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Request for Site-Specific Alternative Deadline to Initiate Closure of CCR Surface Impoundment

Development of Alternative Capacity is Technically Infeasible Demonstration (40 CFR § 257.103(f)(1)) for the East Ash Pond at the F.B. Culley Generating Station

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Acronyms

ASD	Alternative Source Demonstration
BOD	Biological Oxygen Demand
BOP	Balance of Plant
CbR	Closed by Removal
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
CiP	Closed in Place
CRW	Clarified River Water
ELG	Effluent Limitation Guidelines
EPA	United States Environmental Protection Agency
F.B. Culley	F.B. Culley Generating Station
FGD	Flue Gas Desulfurization
GPD	Gallons Per Day
GWPS	Groundwater Protection Standards
IDEM	Indiana Department of Environmental Management
IFC	Issue for Construction
IRP	Integrated Resource Plan
IURC	Indiana Utility Regulatory Commission
MGD	Million gallons per day
MM	Million
MSL	Mean Sea Level
MW	Megawatt
NPDES	National Pollution Discharge Elimination System
POTW	Publicly Owned Treatment Works
RFP	Request for Proposal
SCC	Submerged Chain Conveyor
SDE	Spray Dryer Evaporator
SIGECO	Southern Indiana Gas and Electric Company
SSLs	Statistically Significant Levels
TSS	Total suspended solids
WWTF	Wastewater Treatment Facility
ZLD	Zero-Liquid Discharge

1 Executive Summary

Southern Industrial Gas and Electric Company (SIGECO) owns and operates the F.B. Culley Generating Station (F.B. Culley Generating Station or F.B. Culley) located in Warrick County, Indiana, southeast of Newburgh, Indiana. F.B. Culley Generating Station currently operates the East Ash Pond, a unit which currently receives both Coal Combustion Residual (CCR) and non-CCR flows associated with the operation of two coal fired generating units; Unit 2 at 100 megawatts (MW) and Unit 3 at 287 MW. The East Ash Pond is a currently operating surface impoundment which is planning for closure in accordance with the requirements of the U.S. Environmental Protection Agency's (EPA's) Final CCR Rule (40 Code of Federal Regulations (CFR) 257, Subpart D or Federal CCR Rule). The CCR Rule (following the Part A updates) requires SIGECO to cease CCR and non-CCR wastestreams into the East Ash Pond as soon as technically feasible, but no later than April 11, 2021 or seek appropriate extensions under 40 CFR § 257.103 to continue operating. As described in this document, SIGECO is requesting an extension of the April 11, 2021 "cease flow" deadline for operation of the East Ash Pond until October 15, 2023.

For continued operation of the East Ash Pond beyond April 11, 2021, two extension mechanisms are available under the final Part A: (1) *Development of Alternative Capacity is Technically Infeasible* (40 CFR § 257.103(f)(1)) or (2) *Permanent Cessation of a Coal-Fired Boiler(s) by a Date Certain* (40 CFR § 257.103(f)(2)). SIGECO has prepared this document to demonstrate that obtaining alternative capacity for the CCR and non-CCR flows at the F.B. Culley East Ash Pond is infeasible before the April 11, 2021 deadline, and additional time is needed to operate the East Ash Pond until alternative capacity becomes available.

Eight (8) alternative capacity options were identified and evaluated based on feasibility and schedule including repurposing existing lined facilities, constructing a new pond, constructing a new wastewater treatment facility, and transporting wastestreams to area treatment facilities. SIGECO has decided to construct a new lined pond for alternative capacity to allow the cessation of non-CCR flows to the East Ash Pond. As described in this demonstration, some CCR flows will be eliminated (through retirement of Unit 2, dry bottom ash conversion of Unit 3, etc.) and the remaining will be addressed within a proposed zero liquid discharge (ZLD) process for management of Unit 3 flue gas desulphurization (FGD)-related wastewaters. Engineering and design associated with these improvements is ongoing, and the systems are expected to be operational prior to the requested "cease flow" date of October 15, 2023.

2 Demonstration Purpose and Objectives

This document has been prepared in accordance with the requirements 40 CFR § 257.103(f)(1) to demonstrate that obtaining alternative capacity for CCR and non-CCR flows at the SIGECO F.B. Culley East Ash Pond is infeasible before the April 11, 2021 "cease receipt" deadline provided in 40 CFR § 257.101(a)(1). Accordingly, SIGECO is respectfully requesting an extension to the deadline for East Ash Pond operations pursuant to the Development of Alternative Capacity is Technically Infeasible criteria under 40 CFR § 257.103(f)(1). This document provides the requested information to support this demonstration.

3 Organization of the Demonstration

For ease of review and verification of completeness, this demonstration has been structured consistent with the specific requirements and criteria under 40 CFR § 257.103(f)(1)(iv). The document structure and contents of each section are as follows:

Section 1 – Executive Summary – The section provides an overview of the document.

Section 2 – Demonstration Purpose and Objectives – The section provides a brief discussion of the document purpose.

Section 3 – Organization of the Demonstration – This section provides a discussion of the document outline and organization, indicating where the various regulatory criteria are addressed.

Section 4 – Facility and CCR Unit Background and Description – This section provides background information associated with the generating station, its current operating scenario, and the CCR unit.

Section 5 – Work Plan for Alternative Capacity – This section addresses the requirements for a work plan described in 40 CFR § 257.103(f)(1)(iv)(A), and includes the following key subsections:

- **Section 5.1 – Evaluation of On-site and Off-site Options for Alternative Capacity –** This section provides a detailed Work Plan for obtaining Alternative Capacity consisting of a narrative discussion of options considered, technical infeasibility demonstrations, and a justification of the option selected (40 CFR § 257.103(f)(1)(iv)(A)(1)).

- **Section 5.2 – Detailed Schedule and Narrative Discussion** – This section provides a detailed schedule of the fastest technically feasible time to complete the measures necessary and a narrative discussion describing the schedule and timeline considerations (40 CFR § 257.103(f)(1)(iv)(A)(2 and 3)).

- **Section 5.3 – Progress Toward Alternative Capacity** - This provides a narrative discussion of the progress made to obtain alternative capacity thus far (40 CFR § 257.103(f)(1)(iv)(A)(4)).

Section 6 – Compliance Certification and Additional Information – This section provides a signed certification that the facility is operating in compliance with this subpart and a summary reference to the requested hydrogeologic and other information (40 CFR § 257.103(f)(1)(iv)(B)). The requested items are provided in appendices.

The recent "A Holistic Approach to Closure Part A: Deadline to Initiate Closure" (Part A) revision to the Federal CCR Rule requires that demonstrations be submitted to EPA for approval no later than November 30, 2020. Following the submission of this demonstration, SIGECO will place a Notice of Intent to apply for a site-specific alternative to initiation of closure due to development of alternative capacity infeasible into its operating record and onto the SIGECO CCR Compliance web page (https://www.vectren.com/reporting/ccr) as required by 40 CFR 257.105(i)(14) and 40 CFR 257.106(i)(14), respectively.

4 Facility and CCR Unit Background and Description

A discussion of the facility, current and future operational scenario, and CCR unit background is provided in the following sections.

4.1 Facility Description and Future Operations

SIGECO owns and operates F.B. Culley Station located in Warrick County, Indiana, southeast of Newburgh, Indiana (see attached **Figure 1**). F.B. Culley is located along the north bank of the Ohio River and Little Pigeon Creek is situated along the southeastern-eastern boundary of the facility. Within its operational life, F.B. Culley has operated two (2) CCR surface impoundments referred to as the West Ash Pond and the East Ash Pond (see attached **Figure 2**). However, only the East Ash Pond is currently in operation receiving both CCR and non-CCR wastestreams. The West Ash Pond (described further below) began closure several years ago and is nearing the completion of closure. Closure of the West Ash Pond is on schedule to be complete by December 17th, 2020.

The East Ash Pond is located in the southeasternmost area of the station and is approximately 10 acres in size. The East Ash Pond was commissioned in approximately 1971 and operates as an unlined CCR impoundment. The East Ash Pond currently receives both CCR and non-CCR flows associated with the operation of two coal-fired generating units: Unit 2 (100 MW) and Unit 3 (287 MW).

As mentioned above, closure activities for the West Ash Pond are currently underway and nearing completion. As such, neither CCR nor non-CCR flows are currently managed and treated by the West Ash Pond. Under a closure plan approved by the Indiana Department of Environmental Management (IDEM), a portion of the West Ash Pond is being Closed by Removal (CbR) and a portion of the pond is Closed in Place (CiP) with a final cover system meeting the requirements of the Federal CCR Rule. The CbR portion of the West Ash Pond closure includes construction of a lined contact stormwater pond. As discussed throughout this demonstration, at a future date this lined contact stormwater pond will also manage non-CCR flows currently treated by the East Ash Pond.

A significant amount of planning and engineering is currently underway at F.B. Culley related to future unit operation and management of future flows. There are also a number of current regulatory milestones associated with these efforts. As discussed in the recently issued Integrated Resource Plan (IRP) report, Unit 2 is slated for retirement in 2023 and current bottom ash and FGD wastewater streams associated with Unit 2 will cease in conjunction with this unit retirement. Unit 3 will remain in operation past 2023 and projects are currently underway for dry bottom ash conversion (scheduled completion by December 31, 2020) as well as implementation of a ZLD process for management of FGD-related wastewaters (scheduled completion by October 15, 2023). The modification (and associated schedule milestones) for Unit 3 bottom ash transport water (December 31, 2020) is the result of a mandate in the facility's current National Pollutant Discharge Elimination System (NPDES) to cease the discharge of Bottom Ash Transport Water no later than December 31, 2020. Additionally, the modifications for the FGD-related wastewaters is the result of a mandate to meet new limits by February 1, 2021 unless the facility commits to retiring Unit 3 or installing a ZLD process, in which case a later compliance date that is no later than December 31, 2023 may be sought. An Order (Cause No. 45052) from the IURC was issued on April 24, 2019 , in which the IURC authorized the capital expenditure for the ZLD technology on Unit 3 (See **Appendix A**). Issuance of this Order was a necessary step in determining the future of Unit 3 and the consequential management of FGD-related wastewater flow. In the event the capital expenditure for the ZLD technology was not approved, the company would have needed to study whether it was feasible to continue operating Unit 3, and any design, engineering, and installation expenditure may have resulted in stranded costs. As mentioned previously, non-CCR flows currently managed by the East Ash Pond will be diverted to the new lined contact stormwater pond currently under construction. Design activities this non-CCR flow diversion are currently underway and the systems will be operational by July 1, 2021.

4.2 CCR Unit Description

The East Ash Pond was commissioned in approximately 1971 and currently operates as an unlined CCR impoundment. Earthen embankments were constructed along the south and east sides of the impoundment. Structural fill from the original construction of the F.B. Culley Generating Station in the 1950s was used to construct the earthen embankment along the east and south sides of the unit, forming the East Ash Pond. The east embankment intersects a natural hillside on the east end of the north side of the impoundment. The perimeter of the embankment is approximately 1,200-feet long, 30-feet high, with exterior side slopes covered with grassy vegetation. The surface area of the impoundment is approximately 9.8 acres and the unit has a normal water operating level of 386 feet above mean sea level (MSL).

Following promulgation of the Federal CCR Rule, SIGECO began working with consultants (AECOM and Haley & Aldrich) to evaluate the East Ash Pond's compliance with the new CCR Rule requirements. The East Ash Pond was certified to be compliant with Federal CCR Rule stability and safety factor criteria. The East Ash Pond is also compliant with the wetlands, fault area, seismic impact zone, and unstable area location restrictions. Groundwater monitoring results associated with the East Ash Pond indicates the data exhibits statistically significant levels (SSLs) of molybdenum and arsenic above Groundwater Protection Standards (GWPS). However, arsenic was subsequently addressed by a successful Alternative Source Demonstration (ASD). Given that the unit is unlined, the East Ash Pond is required to cease CCR and non-CCR flows by April 11, 2021 (under the provisions of the recently effective Part A) and either initiate closure or seek appropriate extensions for continued short-term operation.

4.3 Extension Mechanism Selection

The East Ash Pond will operate until October 2023 (upon Unit 2 retirement and completion of other flow-related redirection and modifications discussed herein) for continued management of CCR because no alternative capacity currently exists (either on or off-site) and it is infeasible to obtain alternative capacity prior to the April 11, 2021 "cease flow" deadline. For continued operation of the East Ash Pond beyond April 11, 2021, two extension mechanisms are available under the final Part A: (1) Development of Alternative Capacity is Technically Infeasible (40 CFR § 257.103(f)(1)) or (2) Permanent Cessation of a Coal-Fired Boiler(s) by a Date Certain (40 CFR § 257.103(f)(2)). Key considerations for each of these provisions and the basis for extension selection are outlined below.

1) _Development of Alternative Capacity is Technically Infeasible_: Under this provision, Owner/Operators are required to demonstrate to EPA that obtaining alternative capacity on-site or off-site is infeasible before April 11, 2021, and that additional time is needed to secure additional capacity. In summary, the demonstration must provide information and technical justification that no alternative capacity exists on-site or off-site and must provide a detailed workplan and schedule that includes technical and narrative discussions of how F.B. Culley will obtain alternative capacity. Following public comment and EPA approval, this provision allows for approval of continued operations up to October 15th, 2023 (for non-eligible unlined CCR surface impoundments) or October 15th, 2024 (for eligible unlined CCR surface impoundments). Under the provisions of Part A, the East Ash Pond is a non-eligible unlined CCR surface impoundment.

2) _Permanent Cessation of a Coal-Fired Boiler(s) by a Date Certain_: Under this provision, a CCR unit may continue to receive flows if the owner or operator also commits to coal-fired boiler closure. As discussed in Part A, the facility must commit to coal-fired boiler retirement and cease flows/complete CCR unit closure by October 17th, 2023 (for units less than or equal to 40 acres). Because Unit 3 will continue operation beyond October 17, 2023, F.B. Culley would not qualify for this extension mechanism and it is not discussed further in this demonstration.

Based on the considerations above, SIGECO has prepared this extension based on the requirements for the *Development of Alternative Capacity is Technically Infeasible* extension provision of Part A. As discussed throughout this demonstration, this selection meets the following criteria for *Development of Alternative Capacity is Technical Infeasible* as referenced in 40 CFR § 257.103(f)(1):

- No alternative disposal capacity is available on or off-site (40 CFR § 257.103(f)(1)(i))
- CCR and non-CCR waste streams must continue to be managed in the CCR surface impoundment because it is technically infeasible to complete the measures necessary to obtain alternative disposal capacity either on or off-site of the facility by April 11, 2021 (40 CFR § 257.103(f)(1)(ii)).

5 Work Plan for Alternative Capacity (40 CFR § 257.103(f)(1)(iv)(A)(1))

The Part A demonstration criteria presented in 40 CFR § 257.103(f)(1)(iv)(A)(1) requires a written narrative discussing the options considered both on- and off-site to obtain alternative capacity for each CCR and/or non-CCR waste stream, the technical infeasibility of obtaining alternative capacity prior to April 11, 2021, and the option selection and justification for the alternative capacity selected. The options considered are further discussed in the following sections.

5.1 Evaluation of On-site and Off-site Options for Alternative Capacity

The East Ash Pond has a current storage capacity of 28.2 acre-feet (9,175,000 gallons) and serves a primary role for plant operations with key functions including solids removal by settling and hydraulic surge. The East Ash Pond, as currently operating, receives an average of approximately 1.65 million gallons per day (MGD) of influent from various plant sources. Several of the flows to the East Ash Pond from Units 2 and 3 (such as FGD wastewater-related flows) are comingled. The flowrates of the primary streams are summarized in **Table 1**.

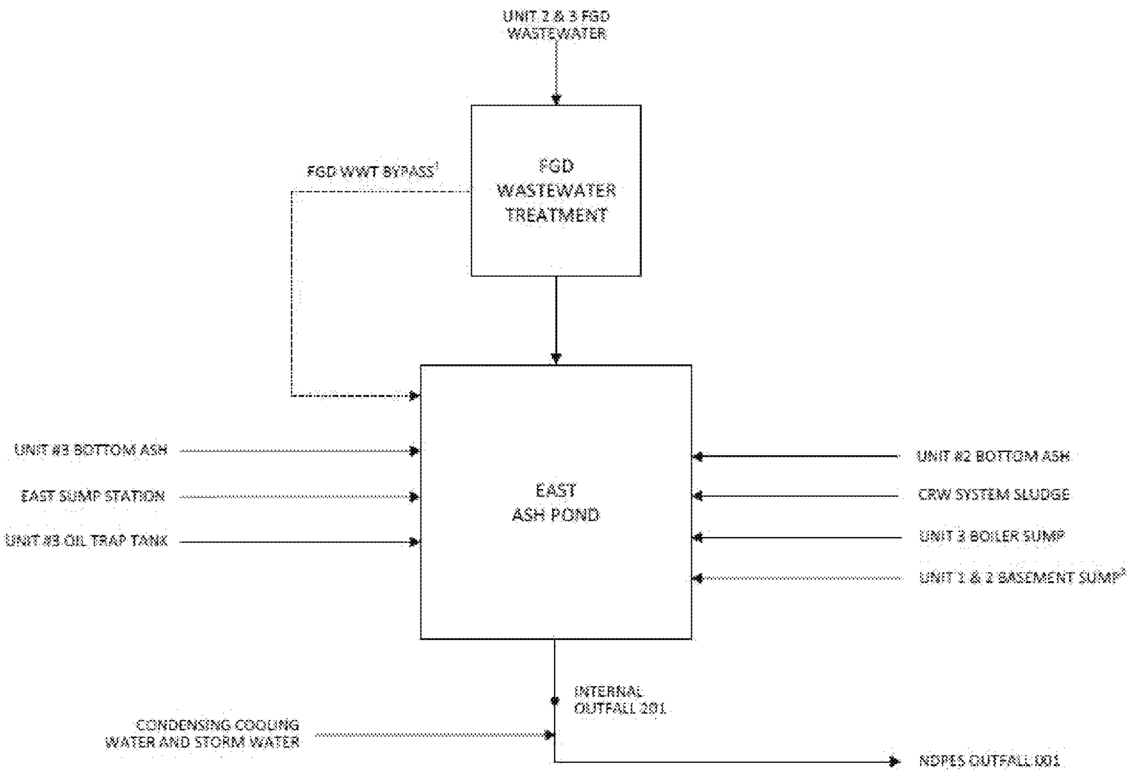
Table 1: East Ash Pond Inflows

CCR Flows			
Source	**MGD**	**Current Management**	**Future Management**
Unit 2 Bottom Ash Sluice Water	0.138	East Ash Pond	Operation ceases 10/2023
Unit 3 Bottom Ash Sluice Water	0.321	East Ash Pond	Dry conversion complete 12/31/2020
Unit 2 FGD Wastewater	0.095	East Ash Pond	Operation ceases 10/2023
Unit 3 FGD Wastewater		East Ash Pond	Flow to be eliminated by 10/15/2023 through conversion to ZLD process
Non- CCR Flows			
Clarified River Water (CRW) Sludge	0.035	East Ash Pond	New Lined Contact Stormwater Pond
Unit 3 Boiler Sump	0.173	East Ash Pond	New Lined Contact Stormwater Pond
East Sump Station	0.792	East Ash Pond	New Lined Contact Stormwater Pond
Unit 1& 2 Basement Sump	0.088	East Ash Pond	New Lined Contact Stormwater Pond
Mix Tank/ Unit 3 Oil Trap	0.0123	East Ash Pond	New Lined Contact Stormwater Pond
Total	**1.65**		

[1]Note Unit 1 has previously been retired.

The flows into the East Ash Pond are discharged through Internal Outfall 201, then combined with condenser cooling water and stormwater and discharged through NPDES Outfall 001. A block flow diagram of the current flows to and from the East Ash Pond is shown in **Figure 3**.

Figure 3: Flow Diagram of Current Flows to/from East Ash Pond



[1] FGD WWT Bypass for [1]emergency use only. [2] Note unit 1 is retired.

The cessation of CCR and non-CCR flows to the East Ash Pond requires alternative capacity to replace the operational functions of the pond, or the plant must be modified to operate without the East Ash Pond. Primary functions of the East Ash Pond that must be replaced include removal of solids and hydraulic storage. Both on-site and off-site options were evaluated as alternative capacity. The following sections detail the options considered and justification for the selected alternative.

When considering the current operations at the F.B. Culley Generating Station and the process for obtaining alternative capacity for the East Ash Pond, the following considerations are key:

- **Unit 3 Bottom Ash Flows** – The East Ash Pond currently manages Unit 3 Bottom Ash Sluice Water (0.321 MGD). The facility's NPDES permit requires elimination of these flows by December 31, 2020 and a project is currently underway to convert Unit 3 bottom ash handling operations to a dry handling system using a submerged chain conveyor (SCC). Because this flow will be eliminated prior to the April 11, 2021 "cease flow" deadline, alternative capacity for the Unit 3 Bottom Ash Sluice Water is not discussed further in this report.
- **Unit 2 Related CCR Flows** – The current CCR flows to the East Ash Pond from Unit 2 include Unit 2 Bottom Ash Sluice Water (0.138 MGD) and Unit 2 FGD Wastewater (0.095 MGD, combined with Unit 3). The public announcement has been made regarding plans to retire Unit 2 by October 15,

2023. As these flows will terminate with unit retirement, it would not be reasonable to expend the effort and capital to design and construct alternative capacity for short term management of these flows. For the purposes of this demonstration, it could be argued that Unit 2 operations could be retired prior to 2023. In this scenario, the East Ash Pond would still be needed to manage and treat non-CCR flows and Unit 3 FGD-related wastewater. Therefore, the process of obtaining alternative capacity for the non-CCR and Unit 3 FGD-related wastewater flows is considered "critical path" and the alternative capacity discussions within this report will focus on primarily on these flows. Also, it is worth noting that the capacity factor for Unit 2 was 15.3% in 2019, 32.1% in 2018, and 22.2% in 2017.

The options and process for obtaining alternative capacity for the non-CCR flows and FGD-related wastewater flows is discussed in the following sections.

Non-CCR Flows

Since approximately 2017, efforts have been in place for the redirection of non-CCR flows managed by the East Ash Pond to the lined contact stormwater pond being constructed as part of the West Ash Pond closure activities. These non-CCR wastestreams are summarized in **Table 2**.

Table 2. Redirected East Ash Pond Non-CCR Inflows

Non- CCR Flows		
Source	**MGD**	**Future Management**
Clarified River Water (CRW) Sludge	0.035	New Lined Contact Stormwater Pond
Unit 3 Boiler Sump	0.173	New Lined Contact Stormwater Pond
East Sump Station	0.792	New Lined Contact Stormwater Pond
Unit 1 & 2 Basement Sump[1]	0.088	New Lined Contact Stormwater Pond
Mix Tank/ Unit 3 Oil Trap	0.0123	New Lined Contact Stormwater Pond
Total	**1.100**	

[1] Note Unit 1 is retired.

Based on commitments to IDEM, engineering is currently underway and these non-CCR flows to the East Ash Pond are scheduled to cease by July 1, 2021 following construction of infrastructure to redirect these flows to the new lined contact stormwater pond. Re-routing of these non-CCR streams to the new contact stormwater pond was underway well before the final Part A and represents the fastest technically feasible alternative for management of these non-CCR flows.

Unit 3 FGD-Related Wastewater Stream

Considering the announced plan for Unit 2 shutdown and the current activities for management of non-CCR flows in the new lined contract stormwater pond, the remaining flow to the East Ash Pond is the FGD wastewater stream from Unit 3. Units 2 and 3 are served by a common FGD system producing one wastewater stream discharge to the East Ash Pond. The FGD wastewater discharged to the East Ash Pond is nominally 95,000 gallons per day (GPD). In evaluating alternative capacity options for the FGD wastewater stream, the NPDES permit requirements for this discharge were considered. New numeric effluent limitations for the FGD wastewater discharge take effect in the near future unless the facility commits to retire Unit 3 or proceed with ZLD for FGD-related wastewaters, in which case a request can be made to modify the NPDES compliance date to not later than December 31, 2023. As SIGECO will operate

Unit 3 into the future (past December 31, 2023), the focus of obtaining alternative capacity has been directed toward a ZLD system for FGD-related wastewaters. As discussed previously, the receipt of the IURC Order in April 2019, which approved the capital investment, was a necessary step in the process of determining the means of managing the FGD-related wastewater flow. While the order approved the capital expenditure for Unit 3, the future of Unit 2 was subject to the outcome of the required 2019-2020 IRP study and subsequent approvals.

The following alternative options were considered for the FGD wastewater flows:

1. Alternative 1 – Repurposing Existing Lined Facilities.
2. Alternative 2 – Construction of a New On-site CCR Rule-Compliant Pond
3. Alternative 3 - Off-site Alternative Capacity
4. Alternative 4 – Temporary Wastewater Treatment Facility
5. Alternative 5 – Advanced Wastewater Treatment System
6. Alternative 6 – Brine Concentrator
7. Alternative 7 – Membrane Separation
8. Alternative 8 – Wastewater Spray Dryer

Descriptions of each treatment alternative and discussion of feasibility at FBC are provided in the sections below.

5.1.1 On-site Alternative Capacity – Pond Systems

Alternatives 1 and 2 consider on-site alternatives involving repurposing of existing ponds or construction of a new pond system. These options are discussed further in the following sections.

Alternative 1 – Repurposing Existing Lined Facilities

For completeness in the alternative capacity option development process, consideration was given to repurposing existing lined facilities for management of FGD-related wastewater flows from Unit 3. In consideration of this option, the only potential option would be management of FGD wastewater flows in the new lined contact stormwater pond as no other ponds currently exist on-site. However, several considerations and limitations render this option infeasible. First, FGD wastewater flows would be considered a CCR flow and the new lined contact stormwater pond (currently nearing completion of construction) was not designed for management of CCR flows and would not meet the requirements for a composite liner system under the Federal CCR Rule (40 CFR § 257.72). Significant retrofit of the liner system would be required that would take considerable time and delay the July 1, 2021 regulatory milestone for management of non-CCR flows in the new lined contact stormwater pond. Further, as the facility's NPDES permit requires ZLD of FGD-wastewater flows by end of 2023 as an alternative to new limitations, use of the new lined contact stormwater pond for management of FGD wastewater flows would only be allowable for a short period (through 2023) and would not be a long-term solution. For these reasons, this option is considered technically infeasible.

Alternative 2 – Construction of a New On-site CCR Rule-Compliant Pond

Construction of a new lined pond on plant property was also considered as part of the options analysis. There is one potential on-site location with potentially sufficient area for a new pond. The area north of the East Ash Pond is not currently utilized for plant operations and could be a potential location for such a pond. **Figure 4** below demonstrates the proposed location of the new pond. Similar to Alternative 1, the new pond would only manage Unit 3 FGD-related wastewater flows on a temporary basis between the future date of pond completion and end of 2023 (when ZLD systems for this stream are required to be in place).

The potential area of the new pond has steep hill slopes that would require significant earthwork to construct a new pond. The area of the new pond is at an elevation significantly higher than the current East Ash

Pond, which would make the re-routing of flows more difficult and would include additional pumps and replacement of existing infrastructure. The area of the proposed pond would also encroach on existing drainage features and potentially require more-lengthy Section 401/404 permitting. Considering these complications, a new pond in this proposed area would likely require 36 months if not longer to complete and would not be feasible prior to the October 15, 2023 deadline.

Based upon the constraints associated with repurposing existing facilities as well as constructing a new pond, it is reasonable to conclude that no options for alternative on-site capacity exists on site for management of the CCR and non-CCR flows described previously. In addition, it is not feasible for alternative capacity to be constructed prior to April 11, 2021.

Figure 4. Potential Location of New On-site CCR Rule-Compliant Pond

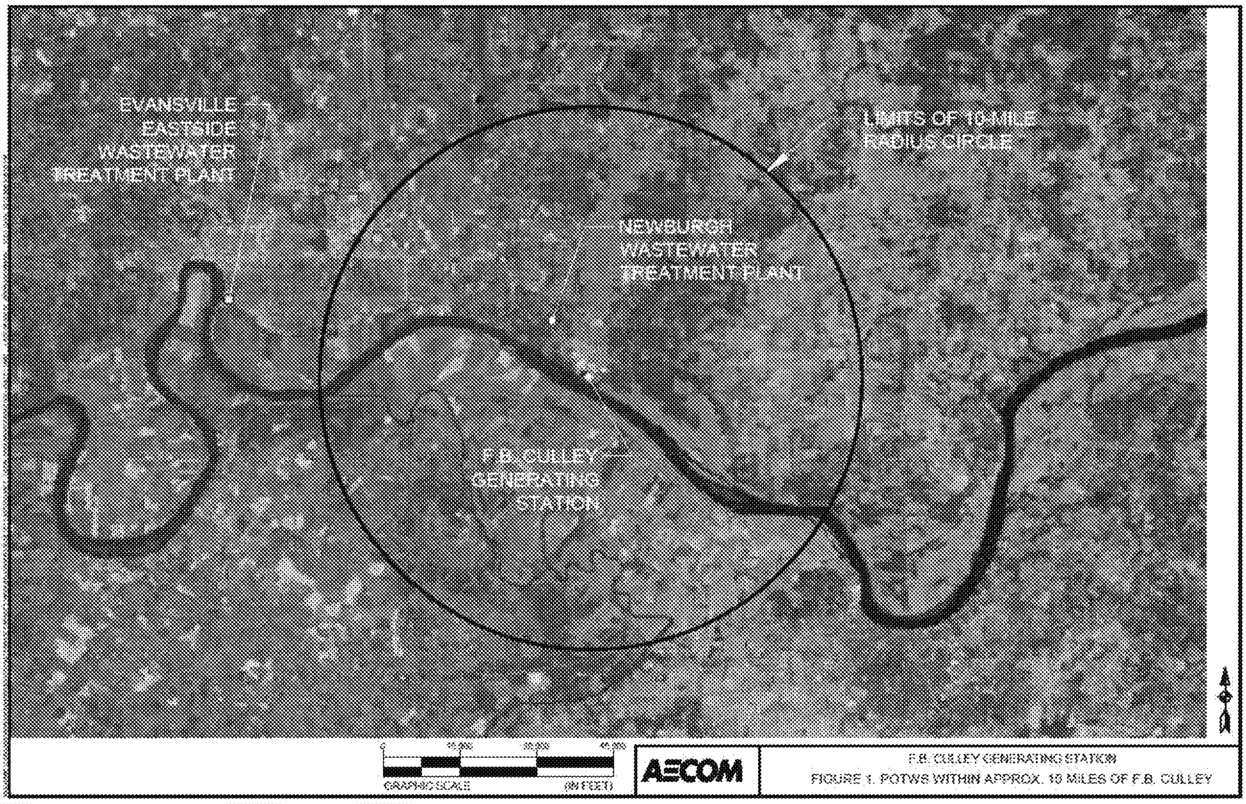
5.1.2 Off-site Alternative Capacity

As required by Part A, off-site options for alternative capacity were also considered. Alternative 3 (described below) was developed to address a potential off-site management option.

Alternative 3 – Alternative Capacity Off-site

Alternatives for off-site treatment of the FGD wastewater flow discharged to the East Ash Pond were evaluated. For this alternative, the FGD wastewater would be transported to either a publicly owned treatment works (POTW) or a private facility capable of managing the wastestream. A 10-mile radius from F.B. Culley was surveyed for POTWs or private facilities that may be capable of treating the waste flows. This radius is shown below, overlaid on the area surrounding the station. The POTW of Newburgh, Indiana, are located approximately within this radius, as shown in **Figure 5**.

Figure 5. POTWs Within 10 Miles of F.B. Culley Generating Station



As shown, the Newburgh POTW is the only wastewater treatment facility (WWTF) located within a 10-mile radius. Evansville Eastside POTW is located just outside this radius. The Regional Water Resource Agency's closest plant, Max Rhoads WWTF (serving Owensboro and Daviess County, Kentucky) was also considered as its straight-line distance from the plant is approximately 12 miles. However, due to the road configuration and limited bridges available across the Ohio River, the actual travel distance to the plant is approximately 25 miles one way, and as such, only the Newburgh POTW and Evansville Eastside POTW were examined in detail.

As the closest POTW, a pipeline to convey the FGD wastewater stream to the Newburgh POTW was considered. The straight-line distance for such a pipeline would be approximately 2.2 miles. For transportation via pipeline, this alternative would require several key items to be completed rapidly to be successful:

- Selection of pipeline route would require the completion of any environmental studies and environmental permitting from regulatory agencies.
- Application for any required federal and/or state permitting required, and timely receipt of approval.
- Acquisition of easements for pipeline right of-way.
- Design of pipeline and any necessary pumping stations.
- Construction of pipeline and pumping stations.
- Final testing.

Given the length of pipeline required and the significant regulatory and design obstacles, construction of a pipeline to a POTW is not the fastest alternative.

Transportation of FGD wastewater flows via truck was also considered. The FGD wastewater flow accounts for 95,000 GPD that would need to be transported to an off-site facility for treatment. Assuming a truck capacity of 5,000 gallons, 19 truckloads would be needed daily to transfer FGD wastewater to the off-site WWTF. Although truck transport of this quantity of wastewater is feasible, since the POTW facilities identified previously treat only municipal wastewater, it is likely that many if not all their processes are incompatible with treatment of the CCR wastewater flows from F.B. Culley.

The existing Newburgh POTW consists of an activated sludge system with eight (8) sequencing batch reactors followed by ultraviolet disinfection. The system is designed to remove total suspended solids (TSS), biological oxygen demand (BOD), and pathogens prior to discharging to the Ohio River, and as such, the facility is not equipped to treat the constituents in FGD wastewater. Additional treatment steps would likely be required to remove dissolved metals to below applicable categorical and local standards. The requirement to pretreat FGD flows removes any benefit of management this wastestream off-site. Given the additional infrastructure required for off-site management and treatment of the FGD wastewater flows, completion of this project is not considered to be technically feasible prior to October 15, 2023.

5.1.3 On-Site Wastewater Treatment Facility Alternatives

The FGD wastewater stream must meet the effluent limitations as defined by the current NPDES permit for F.B. Culley. The F.B. Culley NPDES permit contains a reopening clause that allows the facility to request a compliance date that is no later than December 31, 2023 for the Unit 3 FGD wastestream if unit retirement or ZLD technology is pursued. In 2017, various options to comply with the NPDES permit were evaluated including ZLD and advanced wastewater treatment. A ZLD technology that would eliminate the FGD wastewater stream was selected. The selection of the ZLD technology was included in a filing to the IURC seeking approval for the capital expenditure. The Order granting approval was issued April 24, 2019. The ZLD technology selected is detailed in Alternative 8.

Alternative 4 – Temporary Wastewater Treatment Facility

A temporary WWTF to treat the FGD wastewater stream for the interim period between April 11, 2021 and the date that flow to the East Ash Pond will cease for the selected alternative was considered. The temporary WWTF would have to manage and treat approximately 100,000 GPD of FGD wastewater. Primary unit operations of this system are to remove and dewater the suspended solids in the flow streams. Two agitated storage tanks with a capacity of 100,000 gallons would be required for storage and equalization of influent. Thickener/clarifiers would be used for primary dewatering and filter press or belt press for secondary dewatering. The TSS discharge from the system must meet the limitation for discharge through the NPDES outfall. Dewatered solids would be loaded in trucks for transport to the landfill. The project scope for this temporary system includes field-erected tanks, engineered equipment, structural steel, buildings, piping, electrical and controls. The duration for project of this scope is estimated at 36 months from conceptual design to initial operation. Due to the long duration required to implement, a temporary WWTF would not be available before the ZLD system is in operation. This option is not a technically feasible alternative.

The use of temporary storage tanks in lieu of the East Ash Pond was also evaluated. The East Ash Pond has a hydraulic retention capacity of just over 9 million (MM) gallons. Temporary tanks are available in a wide range of sizes from 20,000 gallon frac tanks to modular field erected tanks up to 1 MM gallons or more. The maximum height of a modular tanks is about 12 feet and therefore they require a large flat area. For example, a modular tank with a capacity of 380,000 gallons is 73 feet in diameter by 10 feet tall. Modular tanks are typically comprised of a bolted steel frame with a geosynthetic membrane. To replace the hydraulic capacity of the East Ash Pond, 450 frac tanks or 9 of the largest modular tanks would be required. A flat prepared area of approximately 5 acres would be required for these temporary tanks. The only potential area is just north east of the East Ash Pond and is the same area that is not suitable for a new impoundment due to the undulating topography. Also, the elevation of this area is higher than the current East Ash Pond and would require additional upgrades to the FGD Wastewater transfer system to discharge to this location, which would require a re-design of the system to maintain the flow rates and velocities that are an imperative aspect of achieving appropriate precipitation of the solids that are being removed from the final discharge.

A primary function of the East Ash Pond is to remove suspended solids by settling. If the Unit 3 wastestreams were redirected to temporary tanks, the suspended solids would settle in the tanks. Due to their small capacity, frac tanks would quickly fill with solids and are not a viable option. The geosynthetic membrane used for the large modular tanks is susceptible to mechanical damage and would likely be ruptured during removal of the solids. This would present an environmental risk if the FGD wastewater was not contained. The FGD Wastewater stream contains 3-5% solids. At a feed rate of 0.095 MGD a 1 MM gallon tank would fill with solids within 2 months rendering it useless for storage capacity. Even if it were feasible to remove solids, once removed would need to be placed in a new containment/processing area for decanting, drying and then loading in trucks for transport to the landfill. This new infrastructure would also have to be designed and installed prior to operation of any temporary tank. Due to the lack of a suitable area to install temporary tanks, the wastestream volume, sensitivities of the chemical-precipitation process, and challenges and risk managing the solids, temporary storage tanks are not a technically feasible option.

Alternative 5 – Advanced Wastewater Treatment System

The F.B. Culley NPDES permit, last modified in February 2018, requires either the installation of a ZLD system for management of FGD wastewater flows (by December 31, 2023) or permanent retirement of Unit 3 in lieu of new limits. As the decision has been made to continue operation of Unit 3 at the F.B. Culley Generating Station, SIGECO has elected to install a ZLD system and discontinue the direct discharge for FGD wastewater by December 31, 2023. SIGECO is executing a project to install a ZLD system as summarized in Alternative 8, the selected option. Installation of an advanced wastewater treatment system prior to April 11, 2021 is not possible and therefore not a feasible option.

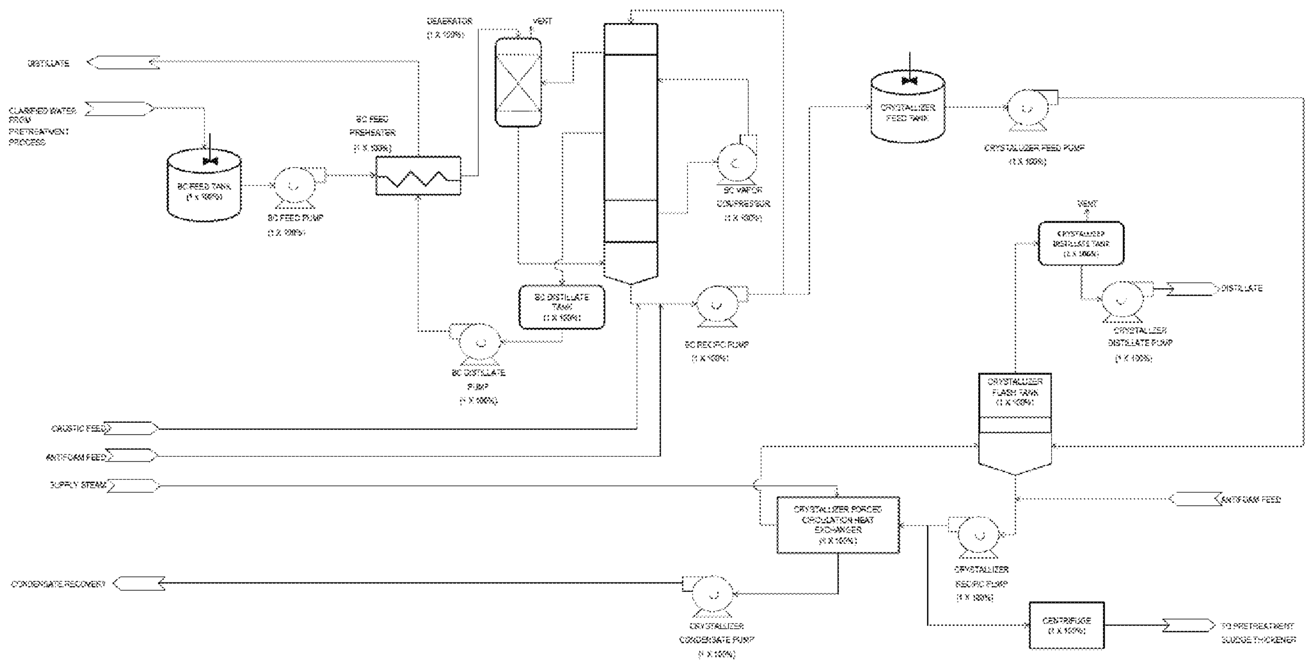
Alternative 6 – Brine Concentrator

A brine concentrator / crystallizer is a ZLD technology. The system is a thermal process that concentrates dissolved species in a brine sludge that is then solidified in the crystallizer unit. Crystallized solids (salts) can then be disposed in a landfill. For an FGD wastewater application, pretreatment steps are required to 'soften' the wastewater prior to thermal treatment to reduce scaling and a reduction in throughput. The softened wastewater is then thermally treated in the brine concentrator or encapsulated with fly ash and lime. Evaporated water, now free of dissolved solids, is collected and returned to the plant as makeup water.

The materials of construction for the brine concentrator and crystallizer must be resistant to corrosion due to the high concentrations of chloride and elevated temperatures associated with the process. As a result, fabrication of the equipment has a long duration and requires over 12 months to procure. Brine concentrator and crystallizer for the FGD wastewater was not the selected option due to reliability issues in comparison with other ZLD options. Total project duration to design, procure, and install a brine concentrator is 36 to

42 months. A schematic of the brine concentration and crystallization steps was prepared by Black and Veatch and is presented as **Figure 6**. While potentially feasible, this option was not selected as the preferred option could be implemented in a shorter timeframe.

Figure 6: Brine Concentrator / Crystallizer Schematic



Alternative 7 – Membrane Separation

Membrane separation is a ZLD technology for treating FGD wastewater. This technology is typically used in conjunction with encapsulation to produce a waste product that can be landfilled. In a reverse osmosis system, a pump is used to convey a high-pressure stream of FGD wastewater across a polymeric membrane. The FGD wastewater salts are concentrated on one side of the membrane while a clean permeate (product stream) stream is discharged from the opposite side. The permeate can be returned to the FGD system as makeup water (ZLD) or discharged. The concentrated brine stream can be blended with fly ash and/or lime and landfilled. Membrane systems require pre-treatment of the wastewater to remove suspended solids and reduce scaling potential. Upstream pre-treatment typically includes clarification, sand filters, cartridge filters, anti-scalant additives, anti-microbial additives and pH adjustment.

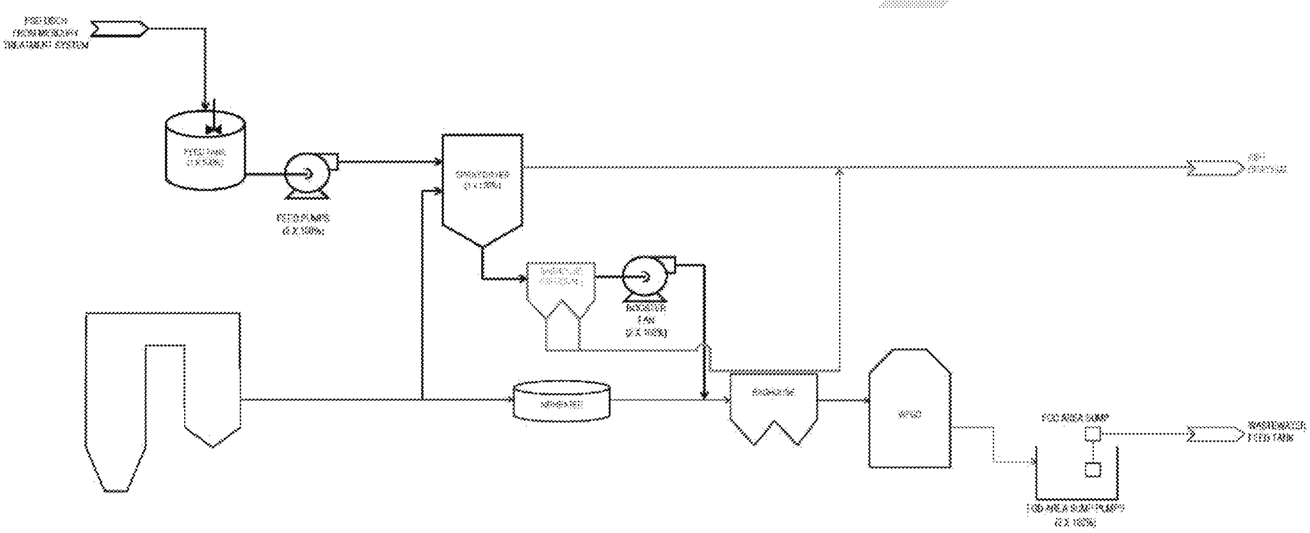
There is limited experience within the utility industry applying membrane separation for the treatment of FGD wastewater. This is an emerging technology and is not expected to be ready for commercial application for several more years. In consideration of the uncertainties regarding long term performance and reliability, and extended duration for project implementation, membrane technology a technically infeasible alternative.

Alternative 8 – Wastewater Spray Dryer

A wastewater spray dryer evaporation (SDE) system uses a slip stream of hot flue gas to evaporate a wastewater upstream of a particulate collection device. Solids and salts in the wastewater are atomized and dried in the spray dryer vessel. The flue gas can either be returned to bulk flue gas stream where the solids are removed with the fly ash or routed to a separate particulate collector prior to being returned with the bulk flue gas. A preliminary process flow diagram of a wastewater spray dryer system is provided in **Figure 7**.

While waste spray dryer technology has only been recently applied to FGD wastewater, it is based on established technology in a similar application. An estimated duration of 36 months is required to design, procure and install a wastewater spray dryer system. This alternative has the fastest feasible schedule of the alternatives evaluated and achieves compliance with the NPDES permit requirements for management of FGD wastewater. It is the selected alternative option for F.B. Culley.

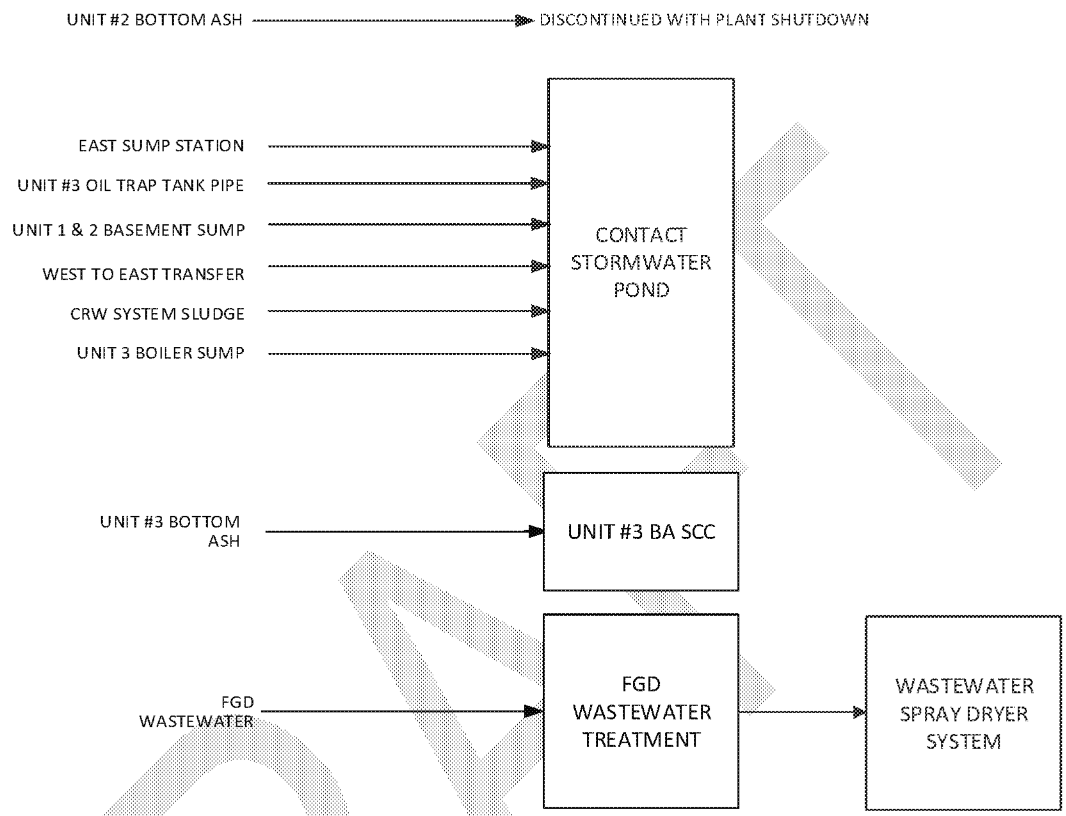
Figure 7: SDE Process Flow Diagram



The flow of bottom ash and FGD streams from Unit 2 will cease in conjunction with the planned shutdown of the unit in October 2023. Alternative capacity for the non-CCR flows to the East Ash Pond will be provided by re-routing to the new lined contact stormwater pond.

A block flow diagram of the reconfigured wastestream flows for the selected alternative is provided in **Figure 8**.

Figure 8: Selected Approach to Obtain Alternative Capacity for FBC Station



Notes:

1. Systems or streams in red denote modifications for the selected alternative capacity option.
2. FGD Wastewater treatment discharge and bypass piping will be decommissioned when the ZLD treatment system is active

5.1.5 Adverse Impact on Plant Operation if the Ash Pond Were No Longer Available (40 CFR § 257.103(f)(1)(iv)(A)(1)(ii))

Given the lack of current alternative capacity, continued operation of Units 2 and 3 at F.B. Culley is wholly dependent on the continued operation of the East Ash Pond until unit shutdown for Unit 2 and alternative capacity is available for Unit 3 FGD Wastewater in October 2023. If the CCR and non-CCR flows to the East Ash Pond were to cease on April 11, 2021 without alternative capacity available, Units 2 and 3 will not be able to continue operation.

F.B. Culley Units 2 and 3 have a combined capacity of 387 MW and currently comprise 27 percent of SIGECO's generating units. F.B. Culley Units 2 and 3 are an essential part of the generation capacity within the fleet and the region, particularly during peak demand periods.

5.1.6 Explanation and Justification for the Amount of Time being Requested and How it is the Fastest Technically Feasible Time to Complete the Development of Alternative Capacity

The continued operation of the East Ash Pond is required until retirement of F.B. Culley's Unit 2 and alternative capacity is available for Unit 3 FGD wastewater. As demonstrated, there are no current feasible options for obtaining alternative capacity for CCR and non-CCR flows prior to October 15, 2023. The East Ash Pond must remain operational until October 15, 2023 for the plant to continue operation.

The selected alternative for management of non-CCR and future closure-related flows represents the fastest technically feasible time to obtain alternative capacity for these flows.

5.2 Detailed Schedule and Narrative Discussion (40 CFR § 257.103(f)(1)(iv)(A)(2) and (3))

The provisions of 40 CFR § 257.103(f)(1)(iv)(A)(2) and (3) require that a detailed schedule be provided illustrating the fastest technically feasible time to complete the measures necessary for alternative capacity to be available including a visual timeline representation. The visual timeline must clearly show the following:

- How each phase and the steps within that phase interact with or are dependent on each other and the other phases (40 CFR §257.103(f)(1)(iv)(A)(2)(i)),
- Steps and phases that can be completed concurrently (40 CFR §257.103(f)(1)(iv)(A)(2)(ii)),
- Total time needed to obtain the alternative capacity and how long each phase and step within each phase will take (40 CFR §257.103(f)(1)(iv)(A)(2)(iii)), and
- At a minimum, the following phases: engineering and design, contractor selection, equipment fabrication and delivery, construction and start-up and implementation (40 CFR §257.103(f)(1)(iv)(A)(2)(iv)).

In addition, 40 CFR §257.103(f)(1)(iv)(A)(3) requires a narrative discussion of the schedule and visual timeline representation which must discuss all of the following:

- Why the length of time for each phase and step is needed and a discussion of the tasks that occur during the specific step (40 CFR §257.103(f)(1)(iv)(A)(3)(i)),
- Why each phase and step shown on the chart must happen in the order it is occurring (40 CFR §257.103(f)(1)(iv)(A)(3)(ii)),
- The task that occur during each of the steps within the phase (40 CFR §257.103(f)(1)(iv)(A)(3)(iii)), and
- Anticipated worker schedules ((40 CFR §257.103(f)(1)(iv)(A)(3)(iv)).

These items are provided and discussed in the following sections.

5.2.1 Regulatory and Other Considerations Associated with Overall Project Schedule

The scenario at F.B. Culley involves a series of interrelated regulatory and technical milestones. In order to address the requirements of this section, two detailed schedule representations have been provided. The first, provided in **Appendix B**, provides a representation of the overall schedule for F.B. Culley, which includes sections for the regulatory process to select future generation technology, CCR-related activities, and alternative pond capacity development activities. This schedule is intended to represent the overall scenario at F.B. Culley and illustrates the interrelationships of the various activities.

5.2.2 Design and Installation Schedule

The cessation of CCR and non-CCR flows to the East Ash Pond requires alternative capacity to replace these functions. Based on current construction schedules, the East Ash Pond will be required to manage non-CCR flows until the contact stormwater pond is complete and operational (by end of 2020) and non-CCR flows can be re-routed (by July 1, 2021 under current NPDES commitments). Unit 3 Bottom Ash flow will be eliminated no later than December 31, 2020 (NPDES requirement). FGD wastewater will continue to be managed in the East Ash Pond until October 15, 2023 when the FGD wastewater ZLD system is complete in accordance with ELG requirements and timetables in SIGECO's NPDES permit.

Essentially, the approach selected to obtain alternative capacity has the following four subprojects:

- **Retirement of Unit 2 Boiler**

Unit 2 Boiler is scheduled to be retired in October 2023; East Ash Pond will be required to manage Unit 2 Bottom Ash and FGD wastewater flows until that time.

- **Unit 3 Boiler Bottom Ash Handling System Wet to Dry Conversion – Submerged Chain Conveyor**

Unit 3 Bottom Ash flow will be eliminated from the East Ash Pond by December 31, 2020, when the new SCC system is completed and functional, which is prior to the compliance date.

- **Closure of West Ash Pond / New Lined Contact Stormwater Pond and Re-Routing of Non-CCR Waste Piping**

Based on current construction schedules, the East Ash Pond will be required to manage non-CCR flows until the contact stormwater pond is complete and operational, which is on schedule to be completed by the end of 2020. At that time, physical construction work to re-route non-CCR flows from the East Ash Pond to the new contact stormwater pond can begin, with a scheduled completion date of no later than by July 1, 2021. Detailed design for re-routing these flows began in July of 2020 and is expected to last 6 months in duration. Following completion of design activities, a 3-month contractor bidding and selection period will occur, with an expected contract award date by end of February 2021. Construction is expected to take 4 months in duration, which includes 2 weeks for start-up and commissioning followed by initial operation of 2 weeks prior to cessation of flow for non-CCR streams to the East Ash Pond by July 1, 2021. A schedule for key milestone activities is found in **Table 3**.

Table 3: Milestone Activities for Re-routing Non-CCR Flows

MILESTONE ACTIVITY	DATE
Design Team Site Visit	6/24/2020
Receipt of 60% Design Documents	10/14/2020
Receipt of 90% Design Documents / Issue Bid Package	12/9/2020
Award Construction Project	2/28/2021
Project Completion/ Cease Flow of Non-CCR Streams to East Ash Pond	7/1/2021

- **Unit 3 FGD Spray Dryer Evaporator for FGD Wastewater**

The selected alternative will require 36 months for design, vendor and contractor selection, equipment fabrication, construction and start-up and commissioning. In consideration of the overall process leading to cessation of flows (both CCR and non-CCR) to the East Ash Pond, this effort is considered critical path. Below is a detailed discussion of the anticipated schedule for implementation.

The project schedule for the selected alternative can be broken down to the following segments:

a. Project Definition and Specification Development
b. Vendor Selection and Award
c. Detailed Engineering and Design
d. Equipment Fabrication and Delivery
e. Contractor Bid, Selection and Award
f. Construction and Start-Up

5.2.2.1 Project Definition and Specification Development

Work on this phase for alternative capacity was initiated in 2020 with project kick-off and the beginning-of-project definition and preliminary design. Prior to this time, evaluations were completed to determine the fastest technically feasible option for compliance for both the CCR and ELG Rule regulations. In the preliminary design phase, the FGD system wastewater stream will be characterized by flowrate and composition. Plant modifications previously identified to reduce the wastewater flow will be assessed. Once the stream has been characterized, a preliminary design and scope will be developed for the wastewater spray dryer system. This phase will include various field investigations, surveys and information gathering to support the vendor's bid and develop the balance of plant (BOP) scope. Key deliverables from this phase includes:

a. Design Basis
b. Plant Water Balances
c. Process Flow Diagrams
d. Overall Site Plan
e. Cost Estimate
f. Major Equipment Specifications

The key objective of the preliminary design phase is to develop a design package and specifications that will be issued as a request for proposal (RFP) for vendor selection for the wastewater spray dryer system. Work from the preliminary design will be used to develop the drawings, documents, and specifications in detailed design. This phase is expected to be completed in 7 months.

5.2.2.2 Vendor Selection Award

Following issuance of the RFP, a duration of 5 months is required for biding, evaluation and award of the wastewater spray dryer system. This includes 2 months for the bidders to prepare proposals and 3 months for evaluation and contract negotiations. Evaluation of the proposals includes a review of the design proposed by the bidders and any alternates that may improve the design or reduce the project schedule. The duration of the evaluation period is dependent on the quality of the proposals received, responsiveness of the bidders to questions and complexity of the alternates considered.

5.2.2.3 Detailed Engineering and Design

The detailed design phase will commence following vendor selection and award. During this time the selected vendor will complete detailed design of the wastewater spray dryer and begin fabrication.

In addition to vendor engineering detailed design and engineering of ancillary equipment and balance of plant modifications will be performed. Planned detail design tasks include pipe stress analysis and supports, design of duct modifications, electrical and control system cable routing and termination, electrical load studies, control narratives, foundation details, and structural and access steel. This activity will be executed concurrently with equipment fabrication and delivery of the wastewater spray dryer by the vendor. To reduce overall schedule duration, detailed design activities will be performed concurrent will occur in parallel with initial construction activities such as site preparation, civil earthworks and foundations.

It may be necessary to accelerate some engineered equipment activities to obtain the certified vendor information required for detailed design. This information may include electrical and controls circuits, equipment interface connections, structural and access details. A total of 12 months is planned for detailed engineering and design. During this phase, Issue for Construction (IFC) packages will be completed by area or discipline and issued to the selected construction contractor. It is anticipated that the issue of these packages will be staggered based on the detail design and construction schedule.

5.2.2.4 Equipment Fabrication and Delivery

Fabrication of the wastewater spray dryer system is on the critical path and expected to require 11 months for fabrication and delivery. This includes the spray dryer vessel and all associated components such as atomizers, feed systems and ancillary components. This activity will occur in parallel with completion of BOP detailed design. Ductwork, structural support and access steel, mechanical components, electrical and controls components comprise the BOP scope. Mechanical components include pumps and agitators, as well as shop fabricated tanks and piping. A duration of 7 months is expected for fabrication and delivery of the BOP components.

5.2.2.5 Contractor Bid, Selection and Award

In this phase, an RFP will be issued to contractors to construct the system. This scope may include erection of the vendor supplied wastewater spray dryer and BOP scope. The bid, selection, and award phase is expected to take 4 months from issuance of the RFP. This includes 2 months for the bidders to prepare proposals and 2 months for evaluation and contract negotiations. Evaluation of the proposals includes a review of the means and methods of construction proposed by the bidders and any alternates that may improve the design or reduce the project schedule. The duration of the evaluation period is dependent on the quality of the proposals received, responsiveness of the bidders to questions and complexity of the alternates considered. These activities occur concurrently with completion of detailed design and equipment fabrication and delivery.

5.2.2.6 Construction and Start-Up

The overall duration for construction is 14 months including start-up and commissioning. Prior to the installation of the wastewater spray dryer, foundations and structural steel will be installed, these activities are expected to require 6 months. The wastewater spray dryer vessel must be installed in a congested area of the power block. This will require work around operating units and detailed lift plans due to limited access and to maintain safety. Spray dryer Vessel and ductwork erection is expected to require 3 months. In parallel with the installation of the wastewater spray dryer, ancillary equipment such as tanks and pumps can be installed, as well as routing piping, and installation of electrical and controls. A duration of 5 months is expected for completion of these activities. A unit outage is required for the ductwork tie-ins to the unit and will need to be coordinated with load demand and the other generating plants in the SIGECO system.

Following completion of construction, the system will undergo start-up and commissioning. This project phase will require 2 months and involves instrument loop checks, motor checks, adjustment of electrical relay settings, hydrostatic testing, mechanical operation of all rotating equipment and various other tasks to prepare the system for operation. Issues discovered during this period may require support from the equipment vendor to address. At the conclusion of this phase, a package with all checkout records will be turned over and the system will be ready for initial operation.

A period of 2 months is allocated for initial operation, during which the process controls loops will be tuned and setpoints adjusted. A key objective of the run-in period is to verify the reliability of the system over a range of operating conditions. Issues that are identified during this phase may require support from vendors or even modification of the system. At the completion of initial operation period, all remaining plant flows to East Ash Pond will cease.

5.2.2.7 Schedule Summary

Based on the schedule provided in **Appendix C**, conceptual design activities for the new lined pond and redirection flows are currently underway. The path to alternative capacity will involve preliminary design, contractor selection, detailed design, procurement and construction. Based on this schedule, it is currently anticipated that flows to the East Ash Pond will cease on October 15, 2023. Throughout the design process, project management efforts will be made to identify schedule improvements.

5.2.2.8 Anticipated Worker Schedules (40 CFR 257.103(f)(1)((iv)(A)(3)(iv)

During construction of the new lined pond and infrastructure to redirect flows, the anticipated worker schedules will consist of 50-hour weeks. This will involve work 5 days per week, working approximately 10 hours per day. If weather or other delays are encountered, the worker schedule may be adjusted (increased) to address this lost time as it is critical systems are complete and operational by October 15, 2023 in order to comply with regulatory timelines.

5.3 Progress Toward Alternate Capacity (40 CFR 257.103(f)(1)(iv)(A)(4))

Part A (40 CFR 257.103(f)(1)(iv)(A)(4) requires a narrative discussion of the progress the Owner/Operator has made to obtain alternative capacity for the CCR and/or non-CCR wastestreams. The narrative must discuss all the steps taken, starting from when the Owner/Operator initiated the design phase up to the steps occurring when the demonstration is being compiled. It must discuss where the facility currently is on the timeline and the efforts that are currently being undertaken to development alternative capacity.

An Environmental Compliance review for continued coal-fired operation at F.B. Culley was performed in 2019 and a Final Report issued in February 2020. The review encompassed the modifications required to comply with the final CCR Rule and ELG Rule and the proposed revisions. Recommendations for modifications to the plant were made in the report and have been summarized in this Work Plan. Summary of projects in progress is as follows:

- Construction of the new lined contact stormwater pond is underway and expected to be completed by December 31, 2020.

- Installation of the Unit 3 SCC system is underway and is expected to be completed by December 31, 2020 in accordance with NPDES permit requirements.

- Re-route of contact stormwater flows from the East Ash Pond to the new Contact Stormwater Pond is underway and expected to be completed by July 1, 2021.

- Design of the Unit 3 dry bottom ash system has been completed (initiated early 2018) and installation of the unit will be complete by December 31, 2020.

- Study work and planning for the FGD Wastewater system has been ongoing since 2017. The early study work and planning included efforts to evaluate the potential for reducing flow volumes and meeting the constituent requirements of the FGD wastewater in order to determine whether the design requirements for a spray dryer system could be achieved. The selection of the ZLD technology was included in a filing to the IURC seeking approval for the capital expenditure. The order granting this approval was issued April 24, 2019. Planning and preparation for design initiation has been occurring throughout 2020 culminating in Owner's Engineer vendor selection in August 2020. Equipment specifications, vendor selection, and BOP design activities for the FGD Wastewater system began in September 2020.

6 Compliance Certification and Additional Information (40 CFR § 257.103(f)(1)(9v)(B))

In accordance with *40 CFR § 257.103 (f)(1)(iv)(B),* the following information and attachments are submitted to demonstrate that the F.B. Culley Generating Station East Ash Pond is in compliance with 40 CFR § 257 Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments (CCR Rule).

In accordance with Federal CCR Rule requirements, groundwater monitoring wells were installed to evaluate the groundwater quality in the vicinity of the East Ash Pond. The analytical results and subsequently ASD efforts resulted in the identification of one constituent, molybdenum, at an SSL exceeding the Appendix IV GWPS. In response, Haley & Aldrich prepared a Corrective Measures Assessment for the East Ash Pond. The Corrective Measures Assessment evaluated the risk related to the molybdenum exceedances and determined there are "no adverse effects on human health or ecological receptors…" from groundwater at the East Ash Pond. Semiannual groundwater sampling will be implemented to continue to monitor and evaluate groundwater through the closure process. Activities toward remedy selection are ongoing.

6.1. Certification of Compliance

The F.B. Culley East Ash Pond is in compliance with the requirements of the CCR Rule. SIGECO manages the company website for the F.B. Culley Generating Station and it is kept up to date and contains all the necessary documentation. **Appendix D** includes the required certification of compliance.

6.2. Visual Representation of Hydrogeologic Information

6.2.1. Groundwater Monitoring Well Locations

A figure detailing the location of the groundwater monitoring wells in relation to the East Ash Pond at F.B. Culley is attached (**Appendix E**). The figure was prepared by Haley & Aldrich.

6.2.2. Well Construction Diagrams

Well construction diagrams and boring logs are attached (**Appendix F**). The well construction diagrams were prepared by Haley & Aldrich.

6.2.3. Groundwater Flow Direction

Figures detailing the groundwater elevation contours of November 2016 and June 2017 to account for seasonal variations are attached (**Appendix G**). The figures were prepared by Haley & Aldrich.

6.3. Groundwater Monitoring Analytical Results

Tables (prepared by Haley & Aldrich) summarizing the constituent concentrations of each groundwater monitoring well sampled between 2016 and 2020 are attached (**Appendix H**). The January 2020 Groundwater Monitoring Report (prepared by Haley & Aldrich) including the ASD efforts is located on F.B. Culley's company website. (https://www.vectren.com/assets/downloads/planning/ccr/Culley%20East%20Ash%20Pond%20Annual%20Ground%20Water%20Report%202020.pdf)

6.4. Description of Site Hydrogeology

A description of the site hydrogeology including stratigraphic cross-sections is attached (**Appendix I**). The description prepared by Haley & Aldrich.

6.5. Corrective Measures Assessment

The corrective measures assessment report is located on F.B. Culley's company website. (https://www.vectren.com/assets/downloads/planning/ccr/Culley-East-Ash-Pond-Corrective-Measures-Assessment-Report.pdf)

Groundwater sampling at the East Ash Pond identified one Appendix IV constituent, molybdenum, in exceedance of GWPS, and the Corrective Measures Assessment was implemented in response to these results. The Corrective Measures Assessment evaluated the potential risk the constituent posed and potential corrective measures to prevent further releases. Groundwater flow was evaluated and found to be radial with an overall flow direction from the upland areas north of the Ash Pond to the South. As discussed in the Corrective Measures Assessment, "Groundwater downgradient of the East Ash Pond is not used as a source of drinking water and is not flowing toward any groundwater supply wells." The risk assessment also demonstrated "no adverse effects on human or ecological health from groundwater uses resulting from coal ash management practices at the F.B. Culley Generating Station East Ash Pond". Potential corrective measures to prevent further releases were identified and evaluated. These measures include Monitored Natural Attenuation, Hydraulic Containment, and In-Situ Treatment. These evaluations are further discussed and compared in the Corrective Measures Assessment.

6.6. Progress Reports

The progress reports on corrective action remedy dated March 2020 and September 2020 are located on the company CCR compliance webpage for the F.B. Culley facility. The reports were prepared by Haley & Aldrich.

March 2020 Report (https://www.vectren.com/assets/downloads/planning/ccr/Culley-East-Ash-Pond-Semi-Annual-Selection-of-Remedy-Progress-Report_2020March.pdf)

September 2020 Report (https://www.vectren.com/assets/downloads/planning/ccr/Culley-East-Ash-Pond-Semi-Annual-Selection-of-Remedy-Progress-Report_2020September.pdf)

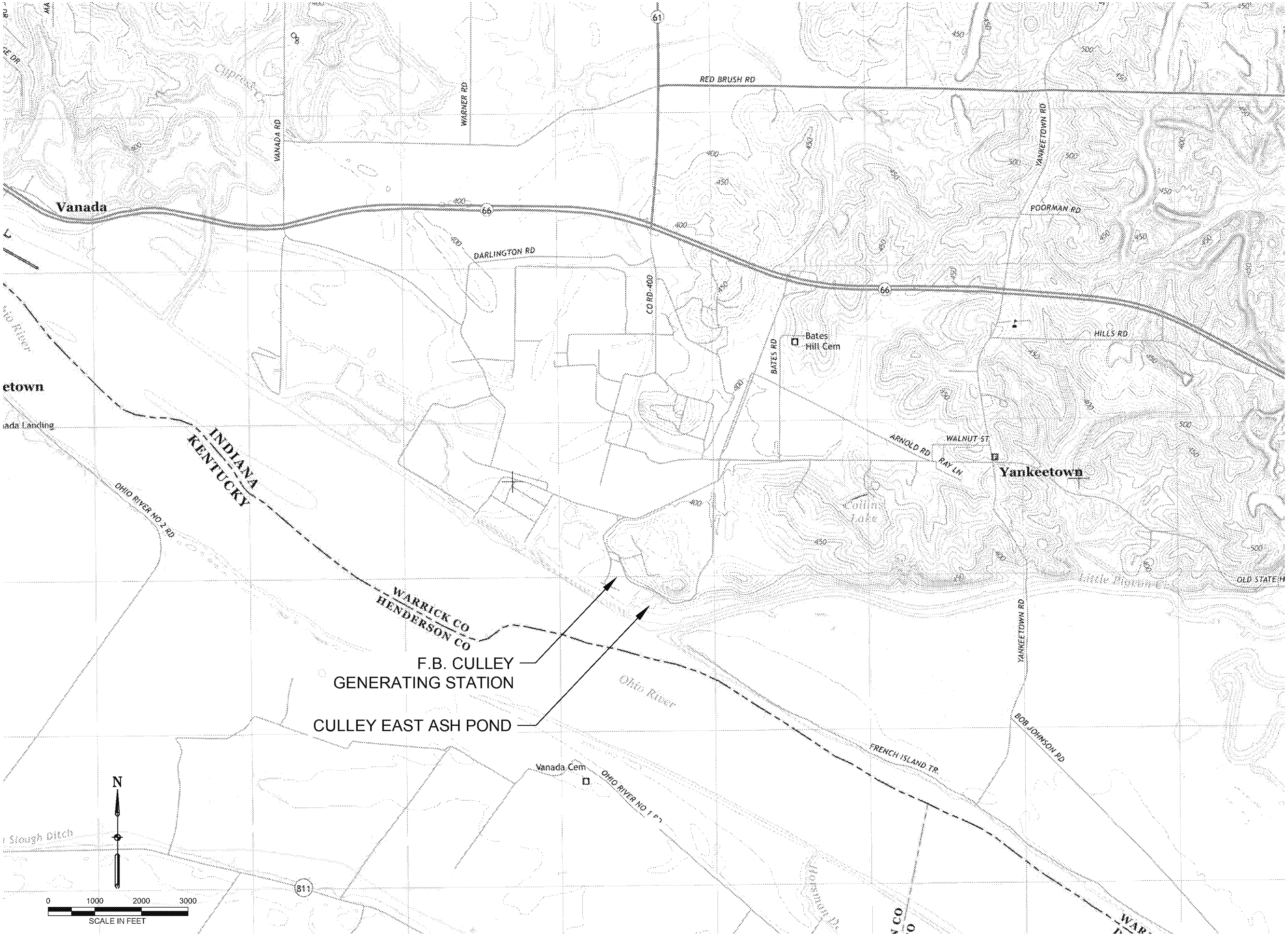
6.7. Structural Stability Assessment

The structural stability assessment report is located on F.B. Culley's company website. The report was prepared by AECOM. (https://www.vectren.com/assets/downloads/planning/ccr/Culley-East-Structural-Stability.pdf)

6.8. Safety Factor Assessment

The factor of safety assessment report is located on F.B. Culley's company website. The report was prepared by AECOM. (https://www.vectren.com/assets/downloads/planning/ccr/Culley-East-Safety-Factor-Assessment.pdf)

Figures



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F.B. CULLEY GENERATING STATION
NEWBURGH, IN

DEVELOPMENT OF ALTERNATIVE CAPACITY INFEASIBLE DEMOSTRATION

ISSUED FOR CERTIFICATION

ISSUED FOR BIDDING — DATE BY

ISSUED FOR CONSTRUCTION — DATE BY

REVISIONS

NO.	DESCRIPTION	DATE
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AECOM PROJECT NO:	60442676
DRAWN BY:	MJC
DESIGNED BY:	MJC
CHECKED BY:	TLE
DATE CREATED:	8/18/2016
PLOT DATE:	4/22/2016
SCALE:	AS SHOWN
ACAD VER:	2014

SHEET TITLE

LOCATION MAP

FIGURE 1

AECOM DRAWING PATH: P:\Projects\Environmental\60442676_VectrenCCR\7.0_CAD_GIS\7.04_Plan_Sheets\CULLEY-LOCATION MAP.dwg

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DEVELOPMENT OF
ALTERNATIVE
CAPACITY
INFEASIBLE
DEMONSTRATION

ISSUED FOR
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REVISIONS

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AECOM PROJECT NO:	60442676
DRAWN BY:	JMW
DESIGNED BY:	JMW
CHECKED BY:	RJB
DATE CREATED:	12/19/2018
PLOT DATE:	12/19/2018
SCALE:	AS SHOWN
ACAD VER:	CIVIL 3D 2018

SHEET TITLE

SITE MAP

FIGURE 2

Appendices

Appendix A
IURC Order in Cause No. 45052

ORIGINAL

STATE OF INDIANA

INDIANA UTILITY REGULATORY COMMISSION

VERIFIED PETITION OF SOUTHERN INDIANA GAS AND ELECTRIC COMPANY d/b/a VECTREN ENERGY DELIVERY OF INDIANA, INC. ("VECTREN SOUTH") FOR (1) ISSUANCE OF A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR THE CONSTRUCTION OF A COMBINED CYCLE GAS TURBINE GENERATION FACILITY ("CCGT"); (2) APPROVAL OF ASSOCIATED RATEMAKING AND ACCOUNTING TREATMENT; (3) ISSUANCE OF A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY FOR COMPLIANCE PROJECTS TO MEET FEDERALLY MANDATED REQUIREMENTS ("CULLEY 3 COMPLIANCE PROJECT"); (4) AUTHORITY TO TIMELY RECOVER 80% OF THE COSTS INCURRED DURING CONSTRUCTION AND OPERATION OF THE CULLEY 3 COMPLIANCE PROJECTS THROUGH VECTREN SOUTH'S ENVIRONMENTAL COST ADJUSTMENT MECHANISM; (5) AUTHORITY TO CREATE REGULATORY ASSETS TO RECORD (A) 20% OF THE REVENUE REQUIREMENT FOR COSTS, INCLUDING CAPITAL, OPERATING, MAINTENANCE, DEPRECIATION, TAX AND FINANCING COSTS ON THE CULLEY 3 COMPLIANCE PROJECT WITH CARRYING COSTS AND (B) POST-IN-SERVICE ALLOWANCE FOR FUNDS USED DURING CONSTRUCTION, BOTH DEBT AND EQUITY, AND DEFERRED DEPRECIATION ASSOCIATED WITH THE CCGT AND CULLEY 3 COMPLIANCE PROJECT UNTIL SUCH COSTS ARE REFLECTED IN RETAIL ELECTRIC RATES; (6) ONGOING REVIEW OF THE CCGT; (7) AUTHORITY TO IMPLEMENT A PERIODIC RATE ADJUSTMENT MECHANISM FOR RECOVERY OF COSTS DEFERRED IN ACCORDANCE WITH THE ORDER IN CAUSE NO. 44446; AND (8) AUTHORITY TO ESTABLISH DEPRECIATION RATES FOR THE CCGT AND CULLEY 3 COMPLIANCE PROJECT ALL UNDER IND. CODE §§ 8-1-2-6.7, 8-1-2-23, 8-1-8.4-1 *ET SEQ*, 8-1-8.5-1 *ET SEQ.*, AND 8-1-8.8 - 1 *ET SEQ.*	)	CAUSE NO. 45052 APPROVED: APR 24 2019

ORDER OF THE COMMISSION

Presiding Officers:
David E. Ziegner, Commissioner
David E. Veleta, Senior Administrative Law Judge

DAO
SNK

On February 20, 2018, Southern Indiana Gas & Electric Company d/b/a Vectren Energy Delivery of Indiana, Inc. ("Vectren South") filed its verified petition in this Cause seeking, among other relief, certificates of public convenience and necessity for a new duct-fired F-class 2x1 combined cycle gas turbine ("CCGT") providing 700 MW of baseload and 150 MW of peaking capacity pursuant to Ind. Code ch. 8-1-8.5 and for certain environmental projects at its Culley Unit 3 generating station pursuant to Ind. Code ch. 8-1-8.4. Petitions to intervene were filed by the Vectren Industrial Group; Valley Watch, Inc., the Citizens Action Coalition of Indiana, Inc., and the Sierra Club ("Joint Intervenors"); the Indiana Coal Council, Inc. ("ICC"), Sunrise Coal, and Alliance Coal, LLC (the "Coal Parties"); SABIC Innovative Plastics Mt. Vernon, LLC; St. Joseph Energy Center, LLP; St. Joseph Phase II LLC; and Evansville Western Railway. All of these petitions to intervene were subsequently granted. A public field hearing was held in Evansville on July 11, 2018, at which time members of the public presented testimony. The Indiana Utility Regulatory Commission ("Commission") held an evidentiary hearing at 9:30 a.m. on October 9, 2018, in Room 222, PNC Center, 101 West Washington Street, Indianapolis, Indiana.

Based upon the applicable law and the evidence presented, the Commission finds:

1. **Notice and Jurisdiction.** Notice of the hearings in this Cause was given and published as required by law. Vectren South is a "public utility" as defined in Ind. Code § 8-1-2-1(a) and Ind. Code § 8-1-8.5-1, an "energy utility" as defined in Ind. Code § 8-1-8.4-3, and an "eligible business" as defined in Ind. Code § 8-1-8.8-6. Vectren South is subject to the jurisdiction of this Commission in the manner and to the extent provided by Indiana law. Pursuant to Ind. Code chs. 8-1-8.5 and 8-1-8.4, Vectren South may seek Commission approval of Certificates of Public Convenience and Necessity. Accordingly, the Commission has jurisdiction over Vectren South and the subject matter of this proceeding.

2. **Vectren South's Characteristics.** Vectren South is an operating public utility incorporated under the laws of the State of Indiana, with its principal office and place of business in the City of Evansville. Vectren South provides electric and gas utility service to the public in Indiana and is subject to the regulation by this Commission in the manner and to the extent provided by the laws of the State of Indiana. This proceeding pertains to Vectren South's electric utility business. Vectren South renders retail electric utility service to approximately 145,000 customers in seven counties in southwestern Indiana, and owns, operates, manages and controls electric generating, transmission and distribution plant, property and equipment and related facilities which are used and useful for the convenience of the public in the production, transmission, delivery and furnishing of electric energy, heat, light and power for residential, commercial, industrial and municipal uses. Vectren South furnishes such electric utility service to retail customers located in Vanderburgh, Posey, Gibson, Pike, Warrick, Dubois and Spencer Counties, with a major portion of such customers residing in and around the City of Evansville, Indiana. Vectren South owns and operates 1,248 megawatts ("MW") of total net generating capacity. This generation capacity is primarily derived from the following five coal-fired baseload units providing a total of approximately 1,000 MW: A.B. Brown 1 (245 MW), A.B. Brown 2 (245 MW), F.B. Culley 2 (90 MW), F.B. Culley 3 (270 MW) and Warrick Unit 4 (150 MW[1]). Vectren South procures 100% of its coal supply from mines located in Indiana.

[1] Represents Vectren South's ½ interest in Warrick Unit 4, a 300 MW unit.

Vectren South's operations are subject to federal, state and local rules promulgated and/or implemented by, among others, the federal Environmental Protection Agency ("EPA"), the Indiana Department of Environmental Management ("IDEM") and by the Environmental Rules Board of the State of Indiana. Such rules establish environmental compliance standards that govern emissions and discharges from Vectren South's electric generating units.

3. Overview of the Evidence.

A. Condition of Current Fleet.

i. Vectren South. The main drivers behind Vectren South's proposal are the age and operating characteristics of Vectren South's existing baseload capacity and the upcoming deadlines for significant capital investments to address environmental regulations. Mr. Wayne D. Games, Vice President of Power Supply at Vectren South, testified regarding the condition of Vectren South's current generation fleet and the challenges facing the fleet. He testified Vectren South's fleet consists of five coal-fired baseload units totaling 1,000 MW. Mr. Games further testified that growth of renewable energy sources and low natural gas prices have negatively affected MISO's dispatch of Vectren South's coal-fired units. Instead of running continuously, Vectren South's units are now cycled up and down throughout the day, or are shut down altogether, decreasing unit efficiency and increasing wear and tear on the units. Mr. Games testified that because the units were not designed to cycle in this manner, the units cannot effectively compete with gas units in particular, which have far better operating flexibility. Continued market reforms are exacerbating this issue and jeopardizing unit availability and reliability.

Mr. Games also explained that the individual units face additional operating challenges. In particular, the A.B. Brown Units rely on scrubbers that utilize a technology that has been abandoned by the industry because of its high variable costs and the vapor it emits which causes corrosion of the unit structure. The scrubbers are already past their expected 30 year design life and present a significant risk to reliability and maintenance costs. He explained that Culley Unit 2 is Vectren South's oldest and smallest unit and that it has the worst heat rate of any coal unit in the state. Finally, he explained the unique circumstances related to the joint operation of the Warrick Unit which creates uncertainty as to the duration of its operation.

Ms. Angila Retherford, Vice President of Environmental Affairs and Corporate Sustainability, testified regarding two new major federal regulatory initiatives – Effluent Limitations Guidelines ("ELG") and Coal Combustion Residuals ("CCR") - impacting Vectren South's coal-generating units. Absent substantial investment at all of Vectren South's coal plants, they must cease operations by December 31, 2023. Ms. Retherford described Vectren South's environmental compliance strategy for the A.B. Brown and Culley units and testified future compliance costs were modeled in Vectren South's 2016 Integrated Resource Plan ("IRP") under the business as usual scenario. Ms. Retherford testified these rules and other existing federal regulatory requirements will require Vectren South to make significant further investment at the A.B. Brown and Culley generating facilities to continue their operation.

ii. Non-Utility Parties.

(1) OUCC. OUCC witnesses Lauren M. Aguilar – Utility Analyst, Anthony A. Alvarez – Utility Analyst and Peter M. Boerger – Senior Utility Analyst testified regarding Vectren South's request for a CPCN to construct the CCGT. These OUCC witnesses testified Vectren South's decision to construct the CCGT is premature because Vectren South has not explored all practical alternatives to extend the life of the A.B. Brown units. OUCC Witness Aguilar ultimately recommended that the decision to build the CCGT be delayed until the end of the 2019 IRP process, in order to allow Vectren South the opportunity to evaluate additional alternatives. The OUCC offered no alternative resource proposal, but argued for a "blended approach" with the possible continued use of existing assets, and suggested that the necessary expenditures to continue use of these assets could be viewed as buying an "option on the future." The OUCC witnesses asserted that deferring any decision until the conclusion of the 2019 IRP process would still allow sufficient time to take action without affecting reliability.

(2) Coal Parties. The Coal Parties' witnesses generally testified that Vectren South should wait to transition its baseload generation from coal to natural gas because the environmental regulations driving the transition, the ELG and CCR rules, are in flux and not yet final. Specifically, the Coal Parties' witnesses testified that recent and anticipated EPA reconsiderations of the ELG and CCR regulations, as well as the potential stay or replacement of the Clean Power Plan ("CPP"), create the potential scenario where Vectren South could operate the A.B. Brown and Culley units beyond 2023 without the need to make material investments in compliance measures. Coal Parties witness Michael J. Nasi – Partner with the law firm of Jackson Walker L.L.P. – further testified that Vectren South's decision to retire its coal plants is premature. He recommended that the decision be delayed until the environmental regulations driving the decision are better understood. With respect to the A.B. Brown units, the Coal Parties suggested that Vectren should investigate an alternative scrubber technology marketed by a Chinese firm to replace the existing dual alkali scrubbers. This technology which uses ammonia creates material that can be sold as fertilizer with revenues used to offset variable operating costs of the scrubber.

iii. Vectren South Rebuttal. Ms. Retherford, who is also a licensed attorney, testified regarding the risks associated with continuing to operate Vectren South's coal-fired fleet and delaying the decision to construct the proposed CCGT. Ms. Retherford testified that recent legal developments related to the CCR rule have made it impossible for Vectren South to continue operating its coal-fired fleet beyond 2023 without significant capital investment. She testified that the current water discharge permits require, and the groundwater monitoring results at the A.B. Brown and Culley ash ponds confirm, that Vectren South must cease discharging coal ash by December 31, 2023, pursuant to the ELG and CCR rules. She also testified that *Utility Solid Waste Activities Group v. Environmental Protection Agency*, 901 F.3d 414 (D.C. Cir. 2018), 2018 U.S. App. LEXIS 23547, confirms that the CCR Rule is final, including the final compliance deadlines at issue in this proceeding. Ms. Retherford testified that pond retirement delay is not an option, and therefore Vectren South must either make investments to comply with the CCR rule or retire the plants before 2024.

In response to the Coal Parties' position that the current administration could alleviate environmental carbon regulations applicable to the coal units, Ms. Retherford testified that the Administration's proposed replacement for CPP does not alleviate the problems. On August 31, 2018, the EPA published its proposed Affordable Clean Energy ("ACE") rule in lieu of CPP. She explained that ACE would increase uncertainty and could actually increase the cost of compliance. For units with high heat rates – such as A.B. Brown – ACE would cause significant future compliance costs.

Vectren South also presented the testimony of Richard McMahon from Edison Electric Institute ("EEI") regarding the growing importance of Environmental, Sustainability and Governance ("ESG") reporting and metrics to the financial community, and the focus of all public electric utilities on being responsive to these topics and establishing explicit carbon reduction targets as part of their public disclosures. Mr. McMahon described the coordinated electric industry response to the demands for ESG reporting, and provided specific examples of lenders and large institutional investors who are putting pressure on companies to transition from dependence on coal units. He explained that Vectren South's 60% carbon emission reduction was in line with similar targets publicly disclosed by its electric utility peers. He also presented information regarding the industry transition from reliance on coal to use of gas as part of the ability to reduce carbon emissions.

As to the potential for alternative scrubbers, Vectren South witness Paul Farber – Principal of P. Farber & Associates, LLC – testified regarding the shortcomings of the technologies presented by Sunrise Coal witness Dombrowski and OUCC witness Aguilar and explained why, from an operational and financial perspective, it would not be prudent for Vectren South to adopt those technologies. With respect to the ammonia based scrubber technology presented by witness Dombrowski, Mr. Farber testified the technology has very limited deployment in the United States and would present a number of operational challenges if installed at baseload coal-fired units like A.B. Brown. These uncertainties and risks posed by adoption of this technology include its cost, its impact on operation of the units (including that it might cause Vectren South to be out of compliance with regulations for other constituents such as mercury and particulate matter absent further types of investments), the unknown ability to sell fertilizer output, and the complications associated with dealing with vendors with no domestic history. He discussed in depth the substantial operational burden and health and Homeland Security risk associated with handling the large amount of ammonia required by such a scrubber. Mr. Farber concluded that the Coal Parties had failed to provide any evidence that the capital costs of this scrubber technology would be any less than the scrubber modeled in Vectren South's 2017 IRP Update. In rebuttal testimony, Jon K. Luttrell, Senior Vice President, Utility Operations and President of Vectren Utility Holdings, Inc., also discussed the cyber security complications and risks posed by adoption of Chinese scrubber technology.

Mr. Farber also responded to OUCC witness Aguilar's criticism that Vectren South "only" evaluated wet limestone and her presentation of potential costs for other technologies. Mr. Farber testified that dry scrubbing is not an applicable technology at A.B. Brown for technical and economic reasons, and therefore it was logical for Vectren South to evaluate wet limestone technology at A.B. Brown. He also testified the cost estimates presented by Ms. Aguilar are not comparable cost estimates to replace the existing scrubbers at A.B. Brown Units 1 and 2.

Mr. Games testified on rebuttal that there simply is no time to delay a decision and await the outcome of another IRP. The Vectren South coal units must be retired or retrofitted by December 31, 2023. Given that there has been nothing to suggest more delay would change the overall economics that the F-class 2x1 CCGT is part of the lowest cost solution under every scenario, there is no reason to believe that modeling in the next IRP would change that result. Mr. Games provided an exhibit setting forth a timeline showing that a delay to allow the next IRP to proceed would leave Vectren South with essentially no baseload capacity for almost three years. During that entire period, Vectren

South customers would be completely exposed to the market for capacity and energy. Per the redirect examination of Justin M. Joiner, Director of Regulatory Policy and MISO Affairs for Vectren Utility Holdsings, Inc. ("VUHI"), this would be during the period when MISO is projecting its largest capacity shortfall for Zone 6 (Indiana). The Commission's Director's Report states "[a]n appropriate planning aspiration is to maintain flexibility while also waiting as long as reasonably possible to commit to a resource." Mr. Games testified on cross-examination that Vectren South has waited as long as reasonably possible.

B. Modeling and Results. Only two parties presented modeling evidence and results. Vectren South presented the modeling from the 2017 IRP Update and the 2016 IRP. Sunrise Coal Witness Philip Hayet presented alternative modeling whereby Vectren South's Preferred Portfolio was delayed by seven years in order to allow existing coal units to continue to operate beyond 2023. Other parties offered criticism of Vectren South's modeling but presented no alternative modeling.

i. 2016 IRP. Vectren South's case was filed in the context of a proposed new rule to govern the IRP process. While our new rule was not effective during the 2016 IRPs, all participating electric utilities complied. This new process is significantly more transparent. It includes the participation of stakeholders, the convening of public meetings, and the submission of and response to comments. Mr. Matt Rice, Director – Research and Energy Technologies, testified regarding Vectren South's IRP process and the results of that process. Mr. Rice described Vectren's approach to its 2016 IRP process and testified Vectren South engaged several industry experts, including Burns & McDonnell and Pace Global, to conduct technical modeling. Mr. Rice testified Vectren South worked with these experts and IRP stakeholders to conduct scenario analysis to evaluate 15 portfolios, each representing a different mix of supply and demand side resources to meet customer load over a 20-year time horizon. He further testified Vectren South worked with Pace Global to conduct a risk analysis and evaluate the 15 portfolios using a balanced scorecard approach. From this analysis, Vectren South identified the "preferred portfolio" which consisted of replacing all existing coal fired generation other than Culley Unit 3 as well as gas peaking units Northeast 1 and 2 and Broadway 1 by 2024 with an F-class .05 Fired CCGT. Mr. Rice testified Vectren South incorporated stakeholder input throughout the process and described the steps Vectren South took to engage stakeholders both before and during the process. This engagement included having stakeholders develop two portfolios which were then modeled and included in the risk analysis.

Mr. Matthew Lind – Associate Project Manager, Burns & McDonnell – described the modeling Burns & McDonnell conducted in the 2016 IRP on behalf of Vectren South to evaluate its resource needs over the next 20 years. He testified the results of Burns & McDonnell's modeling identified a low-cost portfolio that ceased coal operations at Vectren South's coal fired facilities (A.B. Brown Units 1 and 2, F.B. Culley Units 2 and 3, and Warrick Unit 4) and replaced this capacity and energy with the combined cycle facility proposed here along with a simple cycle facility. Mr. Gary Vicinus – Managing Director for Utilities at Pace Global – described Pace Global's role in identifying and defining the objectives, metrics and risks in order to select the preferred portfolio among the many options. He testified Pace Global used a balanced scorecard approach to apply a risk analysis to a selection of portfolios ultimately to recommend a preferred portfolio. Mr. Vicinus further testified regarding revisions Pace Global made to its risk analysis and explained that, even with these revisions, the risk analysis indicated the preferred portfolio was the best approach.

Mr. Rice described the preferred portfolio and explained why it ranked the best on the balanced scorecard. He testified it performed the best because the portfolio is diversified as it contemplates keeping FB Culley 3 (a coal unit) and existing wind contracts, building a CCGT and introducing solar and continuing to offer energy efficiency. He further testified it is among the lower cost portfolios (within 4% of the predominantly gas lowest cost portfolio) and ultimately performed best overall when viewed across multiple measures on the balanced scorecard. Because the all-gas portfolio represented the lowest cost portfolio, it is the retention of Culley Unit 3 and the accelerated addition of the 50 MW solar project that increases the costs of the Preferred Portfolio over the lowest cost all-gas portfolio. Retention of coal and the addition of solar are essential to diversity.

ii. 2017 IRP Update. Mr. Lind testified Vectren South requested Burns & McDonnell to update the 2016 IRP modeling and the re-evaluated low-cost portfolio was consistent with the low-cost portfolio identified in the 2016 IRP. He explained that several modeling inputs were updated, including the capital cost for solar resources, variable production costs and revenue requirements for existing units, an assumed operation of Warrick Unit 4 through 2023, and updated cost assumptions for capacity, energy, natural gas, coal, and energy efficiency.

OUCC witness Peter Boerger testified regarding Vectren South's 2017 IRP Update economic modeling. Mr. Boerger testified that Vectren South's 2017 IRP Update did not adequately consider viable options for serving its customers—including making use of existing resources and adequately considering the addition of a smaller CCGT unit rather than the 2x1 unit being proposed. Mr. Boerger also testified Vectren South's modeling of the proposed CCGT understated its capital cost by $200 million, an error which disadvantaged other options in Vectren South's modeling. Mr. Boerger ultimately recommended Vectren South reevaluate its future needs and model additional alternatives.

CAC witness Tyler Comings – Senior Researcher at Applied Economics Clinic – testified on behalf of the Joint Intervenors. Mr. Comings criticized Vectren South's modeling, testifying it was too convoluted to yield a sufficiently transparent or credible result. He testified Vectren South used too many models in the selection of the preferred portfolio and that the use of many models created ample opportunity for flawed and/or inconsistent input assumptions and other settings that could create bias in favor of the preferred plan. Mr. Comings ultimately recommended Vectren South's petition be denied because, in his view, Vectren South did not provide sufficient justification for its choice to build the CCGT and continue the operation of Culley 3.

Indiana Coal Council witness Emily Medine – Principal in the consulting firm of Energy Venture Analysis, Inc. – also testified regarding Vectren South's modeling. Witness Medine testified Vectren South should have fully updated its 2016 IRP analysis, including its scenario analysis, in order to confirm its preferred resource portfolio. She further testified that such an update should include a broader analysis (including sensitivity analyses) of the relevant assumptions and factors as of a time as close to Vectren South filing its Petition as possible. Ms. Medine attributed the decision to build a CCGT to financial motivations and also opined that approval of the CCGT might be a condition to closing the Vectren South merger transaction.[2] Ms. Medine recommended that Vectren South's Petition be rejected because Vectren South has failed to show that proceeding with building the CCGT at this time is prudent, less risky, and a better decision for both customers and the environment.

[2] While this case was pending, it was announced publicly that Vectren South's holding company was the subject of an acquisition at the holding company level, which was the subject of Cause No. 45109.

Mr. Lind responded to Mr. Boerger's testimony about an alleged $200 million "error." He explained that approximately $67 million of the alleged error identified by Mr. Boerger was due to Mr. Boerger's mistaken assumption about whether modeled option costs are stated in 2017 dollars or nominal dollars in the year of incurrence. The remainder is due to Mr. Boerger's efforts to compare apples and oranges. As Mr. Lind explained, the modeling was done prior to the more refined cost estimates for the CCGT that were developed for this case. Rather than based on a design level accuracy of plus/minus 50%, the CCGT design has been refined to a plus/minus 10%. All of the other portfolios were still at plus/minus 50%. As Mr. Lind explained, to compare the other less refined portfolios to the more refined CCGT would require some additional risk factor for the other portfolios. But even if one includes the updated cost estimate, Mr. Lind testified that it doesn't change that the lowest cost portfolios still include the CCGT. Mr. Lind prepared additional modeling involving coal-to-gas conversion (which we will describe later) and which did include the more refined CCGT cost estimate. While this additional modeling used the more precise CCGT cost and therefore impacted every portfolio that included the CCGT by increasing the overall net present value ("NPV") by $54 million, the portfolios that included the CCGT were still the lowest cost portfolios compared to portfolios that did not include the CCGT. Regarding the use of the models, witnesses Lind and Vicinus confirmed that the process and modeling for Vectren South's IRP and risk analysis were consistent with the resource planning approach Pace and Burns & McDonnell have used for numerous other utilities.

(iii) Size of the Proposed CCGT. Joint Intervenors' witness Tyler Comings testified regarding the size of the proposed CCGT. Witness Comings testified that Vectren South has not provided a sufficient justification to build a CCGT of the size included in its proposal. Witness Comings also criticized Vectren South's Request for Proposals ("RFP") (which we will describe in greater detail later) which sought resources between 600 and 800 MW, because he believed Vectren South could have considered combinations of small resources that added up to 600 MW. He further testified that considering smaller options would limit the market risk exposure for ratepayers, as well as permit a combination of bids to make up a least cost alternative. Mr. Comings testified that in order to reduce ratepayers' risk, Vectren South should explore cost effective alternatives that do not require intensive capitalization, but still provide benefits to ratepayers.

OUCC witness Anthony Alvarez also testified regarding the size Vectren South is proposing for the CCGT. Mr. Alvarez testified that Vectren South currently has excess supply, and there is no resource shortfall or inadequacy that supports Vectren's proposed 850 MW CCGT. He also questioned the load forecast used in the IRP and testified Vectren South has excess supply after serving its peak load and therefore has excess capacity to offer into the market and serve new customers.

Industrial Group witness Michael Gorman also testified regarding the size of Vectren South's proposed CCGT. Mr. Gorman testified Vectren South's proposal to build an 850 MW CCGT will result in excess capacity and have a compound impact on Vectren South's cost of service because the plan increases the costs of new generation resources and results in unrecovered stranded costs from the retired resources. Mr. Gorman recommended the Commission implement mitigation measures to reduce the cost burden on customers related to stranded costs and the cost of the new CCGT. He also recommended the Commission modify the off-system sales margin treatment so that 100% of future wholesale revenues be provided to customers to offset the cost of the proposed resource plan.

Vectren South witness Carl Chapman testified on rebuttal regarding Vectren South's decision to construct an 850 MW CCGT. Mr. Chapman explained the CCGT is essentially two units -- a 700 MW baseload unit to replace 730 MWs of retiring coal unit capacity and 150 MWs of duct fired peaking capacity to replace older peaking units and provide available low cost capacity for growth and wholesale sales opportunity. The additional peaking capacity is provided by the decision to duct-fire the CCGT. The incremental cost of duct-firing the CCGT is $15 million, and that decision must be made at the time the CCGT is constructed (i.e., it cannot be added at a later time.) Mr. Chapman testified that if only the unfired 700 MW baseload CCGT is built, then by 2025, Vectren South has a projected surplus above MISO's Planning Reserve Margin ("PRM") (which fluctuates) of only 51 MW. He further testified that by 2030, the surplus is only 5 MWs and by 2031 Vectren South will fail to meet its PRM. He testified that by 2036, Vectren South will be short 39 MWs, and all of this assumes Vectren South will not add significant new load. Mr. Chapman testified that with its low capital cost, firing makes sense from a customer perspective. For an incremental cost of 2%, the firing provides a 21% increase in capacity. Nevertheless, if the Commission approves the baseload 700 MW CCGT without firing, Vectren South will proceed to construct the unfired CCGT to replace its baseload coal units. He stated that Vectren South would also consider investing the incremental $15 million to duct-fire the unit and be at risk to recoup its investment via retention of the wholesale revenue produced by that peaking capacity.

Mr. Chapman also testified regarding Industrial Group witness Gorman's recommendation that Vectren South pass off-system sales margins on to retail customers. Mr. Chapman testified that Vectren South has decided to commit to provide 100% of wholesale sales revenue from the CCGT (baseload and peaking) to customers. Mr. Chapman explained that once the CCGT is placed in rate base, the benefits from the wholesale revenue produced by the unit will go to reduce customer costs. Mr. Chapman testified that providing 100% of wholesale revenue to customers further improves the NPV of the CCGT, will provide a larger offset to customer costs in general, and adds even more support to the $15 million incremental investment to duct fire the unit.

C. **Coal Parties' Modeling.** Indiana Coal Council, Inc. witness Philip Hayet – Vice President of J. Kennedy and Associates, Inc. – testified regarding Vectren South's 2016 IRP modeling and the 2017 IRP Update. Mr. Hayet testified that Vectren South's modeling analyses were flawed due to errors, inconsistencies, and a lack of consideration of important factors. Mr. Hayet performed his own analysis and testified that using the same model with certain corrections, including a deferral of a decision to add a CCGT, produced a slightly lower cost result on a NPV basis. He predicated his modeling on the assumption that the A.B. Brown 2 scrubber will continue to operate reliably through 2030. He ultimately recommended that Vectren South defer its decision to construct the CCGT.

On rebuttal, Vectren South witness Matthew Lind testified regarding Indiana Coal Council witness Hayet's alternative modeling. Mr. Lind testified that when Mr. Hayet's modeling is corrected for obvious errors, it reaches the same preferred portfolio conclusion as Vectren South's modeling. Mr. Lind provided corrections to Mr. Hayet's modeling in the form of an updated Strategist model and spreadsheets documenting the corrections. Mr. Lind outlined each of the errors he identified in Mr. Hayet's modeling and the impact of the individual errors on his analysis. The first of several errors he identified was that Mr. Hayet failed to include cost escalation during the seven years of delay that he was urging and that correcting this error alone would change Mr. Hayet's overall conclusion that delay would be less costly. Mr. Lind also testified regarding the cumulative effect of addressing all of the errors. As part of this analysis, Mr. Lind testified that he included the increased cost of the CCGT to reflect the more recent cost estimates based on a plus or minus 10% confidence level. He testified that when correcting Mr. Hayet's modeling for all of these errors and inconsistencies, the NPV favors Vectren South's preferred portfolio, even under Mr. Hayet's no carbon regulation scenario. Witness Hayet corrected his testimony after Mr. Lind filed his rebuttal to add the escalation during the period of delay he was urging, and this correction changed his original conclusion that delay was less expensive. Mr. Hayet did not address the other modeling issues raised by Mr. Lind.

Mr. Games' rebuttal testimony also addressed witness Hayet's assumption that the A.B. Brown 2 unit and scrubber could be operated without added cost and reliability risk through 2030. Apart from the reliability issues created by the frequent cycling of the unit, he explained the structural damage resulting from the corrosive environment created by the unique characteristics of these scrubbers, and based on his direct experience with this equipment, Mr. Games concluded that he could not agree that it would be prudent to continue to operate the A.B. Brown 2 scrubber for another 12 years beyond 2018.

D. <u>Renewables and All-Source RFP</u>. Joint Intervenor witness Tyler Comings criticized the costs assumed in Vectren South's modeling for most renewable energy sources. Mr. Comings testified that Vectren South's forecast of the capital costs of future wind resources is higher than he would have recommended for the type of planning analysis and its forecast of the fixed O&M costs are lower. Mr. Comings recommended the use of the National Renewable Energy Laboratory's Annual Technology Baseline ("ATB") to develop the forecasts. With respect to future solar resources, Mr. Comings testified Vectren South's forecasts are too high for both the capital and fixed O&M costs. Mr. Comings recommended the reliance on the ATB to develop wind and solar price forecasts. For utility-scale PV, he testified that the ATB midpoint projection would be appropriate. As part of his discussion of renewable costs, he noted that Northern Indiana Public Service Company ("NIPSCO") had recently conducted an RFP and obtained solar and wind bids. Mr. Comings testified that Vectren South's overestimation of renewable costs compared to the ATB data biased the modeling results against renewable resources in favor of non-renewable resources, such as natural gas.

On rebuttal, Mr. Lind responded to Mr. Comings' testimony related to the cost of renewables included in Vectren South's modeling. With respect to wind resources, Mr. Lind noted that prior to revising his testimony, Mr. Comings' originally filed testimony included an inaccurate and inappropriate comparison of assumed capital cost for wind resources between Vectren South and ATB because Mr. Comings failed to account for the declining cost curve over time utilized by Vectren South. Mr. Lind testified that when Mr. Comings updated his testimony to reflect this decline, he recognized that Vectren South's wind costs are only "slightly higher" than what Mr. Comings recommends. Mr. Lind further testified that even with this correction, Mr. Comings' comparison to the ATB figures is incorrect because the ATB figure excludes a 2.1% construction finance factor and is thus understated. Mr. Lind testified that when the 2.1% construction finance factor is included, the ATB capital cost will exceed Vectren South's modeled capital cost for wind over more than half of the planning period. Mr. Lind pointed out that Vectren South assumed a higher capacity factor than the ATB survey and also assumed lower O&M costs compared to the ATB survey, and as a result, it is likely that the wind prices recommended by Mr. Comings are actually higher than those modeled by Vectren South.

With respect to Mr. Comings' criticisms of Vectren South's solar costs, Mr. Lind testified Mr. Comings again failed to account for the declining cost curve over time in the original version of his testimony. Mr. Lind further testified that while Mr. Comings did update his comparison to reflect the decline, he did not update it to include the 2.1% construction finance factor in the ATB comparison. Moreover, Mr. Lind explained that the national survey costs relied upon by Mr. Comings were presented on a direct current (DC) basis, whereas the 2017 IRP Update stated cost in terms of alternating current (AC), thus requiring that Comings' costs be converted to AC to allow for a valid comparison to be made. When correcting for these additional errors, Mr. Lind testified the solar costs used by Mr. Comings and Vectren South are nearly consistent over the last half of the study period and fairly similar from 2024 onward, which is the point at which capacity is needed.

Mr. Lind also testified regarding the impact of network upgrades and congestion costs on a portfolio that would rely more heavily on renewables. Mr. Lind testified that a portfolio which would rely heavily on renewables to supply power to Vectren South's customers is more likely to source some or all of these resources remote to Vectren South's service territory given the acreage required for such projects, the grid issues that can be encountered, and the enhanced production that can be obtained in certain locations (e.g., northern Indiana). Mr. Lind explained that when significant amounts of power are sourced from off-system resources, congestion costs to Vectren South's customers increase substantially. Because such costs were not part of the 2017 IRP Update assumptions, Mr. Lind concluded that any small differences between the solar costs presented by Mr. Comings and those modeled by Vectren South would be more than offset by the congestion costs associated with greater reliance on such resources. Finally, Mr. Lind noted that even assuming lower renewable costs could be achieved, such resources would likely displace Culley Unit 3's 270 MWs of capacity because that could be done incrementally to reduce the effects of network upgrades and congestion, whereas the CCGT would remain the optimal low cost choice to replace the remaining 730 MWs of retiring coal capacity in 2023. Further, wind and solar are intermittent sources of power; given that Culley Unit 3 would be Vectren South's only baseload capacity under its preferred portfolio, dispatchable baseload generation from a CCGT provides greater flexibility to respond to intermittent resources.

E. <u>Capacity Price Forecasts</u>. Mr. Comings testified regarding Vectren South's ability to purchase future needed capacity from the MISO market. Mr. Comings testified that Vectren South overestimated future capacity prices in MISO in its modeling, and in reality, the MISO market has had an oversupply of resources and tempered demand, leading to low capacity prices. He testified Vectren South's assumption of higher capacity prices is critical, because it makes the economics of building a new resource more attractive. He concluded that Vectren South was placing risk on its customers if the price of capacity is lower. To reach his conclusion, he relied on the MISO auction clearing results for Zone 6 (Indiana) for the past five years. Indiana Coal Council witness Hayet had a similar criticism of Vectren South's modeled capacity prices. He agreed that the cost of new entry ("CONE") served as the upper end of future capacity prices but that, also based on MISO historic auction clearing prices, it was inappropriate for future assumed capacity prices to approximate CONE. Instead, witness Hayet proposed to use 75% of CONE.

On rebuttal, Vectren South witness Joiner responded to Mr. Comings' testimony related to Vectren South's alleged overestimation of MISO capacity prices. Mr. Joiner testified he disagreed with Mr. Comings' contention that Vectren South should assume it will be able to purchase capacity and energy from the MISO market at low prices based upon recent market conditions. Mr. Joiner explained that the MISO market has been volatile in recent years and is experiencing shrinking capacity, and such factors have prompted MISO to evaluate changes to its market structure. Mr. Joiner testified that MISO's recent and pending market reform initiatives, including MISO's Resource Availability and Need ("RAN"), are aimed at increasing capacity and energy prices to incentivize new generation development and are thus leading to higher prices as capacity tightens. As such, Mr. Joiner testified that while MISO's historical capacity and energy prices are indicators of recent trends, contrary to Mr. Comings' MISO auction clearing price testimony, they are not good indicators of expected, long-term future pricing. Moreover, the reported potential for a capacity shortfall by 2024 shows the risk of increased market prices.

F. Refueling Options. OUCC witness Boerger recommended that Vectren model a smaller 440 MW CCGT option in conjunction with gas refueling of one or both A.B. Brown units in order to consider a lower capital cost alternative. This option, which replaces retired coal units with a smaller gas baseload unit, was consistent with his stated concern that implementation of large quantities of intermittent renewables could create grid difficulties and that the extension of the life of small coal units is not common in the industry.

Mr. Lind's rebuttal presented the results of additional modeling in response to the OUCC's interest in further analysis related to resource plan options including coal-to-gas conversion that would make use of the A.B. Brown unit boilers. Burns & McDonnell performed that modeling and analyzed four additional portfolios, each where the conversion of one or more units to natural gas was considered. Mr. Lind testified that this updated rebuttal modeling used the more refined cost estimates (at the plus/minus 10% confidence level) for the CCGT for comparison with the coal-to-gas conversion portfolios (which were stated at plus/minus 50% accuracy.) Mr. Lind described the results of the updated analysis and testified that when compared with the coal-to-gas conversion portfolios, the preferred portfolio still produces a lower NPV and projected customer cost. Witness Games explained that this is due in part to the high heat rates of refueled units which result in very poor dispatch rates and resulting reliance on the market for energy needs. He explained that such a portfolio would result in customers significantly depending on market purchases for energy. Witness Games testified the fuel cost per MWhr from a converted gas plant is roughly $20 more expensive than the cost from the proposed CCGT when gas price is $4.000/dkt. He showed the much higher heat rates and lower capacity factors at converted plants that were completed between 2013 through the first quarter of 2018. Mr. Games testified during the hearing that the problem of high heat rates means that the refueled units continue to cycle and ramp up and down when dispatched, leading to wear and tear and the risk of additional maintenance costs.

G. Docket Entry Question & Response. As a follow-up to the additional modeling performed by Vectren South on rebuttal of gas conversion options, we issued a Docket Entry requesting further iterations of gas conversion portfolios. These included refurbishment of Broadway Unit 2 coupled with delays of removal of Warrick Unit 4 and installation of either a simple cycle or combined cycle gas turbine. Vectren South's response included the more refined cost estimate of the CCGT at plus/minus 10%, excluded additional environmental compliance costs at Warrick Unit 4 that would allow for the delay, and were presented with and without the commitment by Vectren South on rebuttal to pass 100% of wholesale revenues to customers if the CCGT is approved. All of the additional modeling requested by our docket entry produced a higher NPV than the lowest cost refueling portfolio presented on rebuttal (to convert A.B. Brown and instill a simple cycle gas turbine). With the sharing of 100% of wholesale revenues, all of the additional modeling produced a higher NPV when compared to the preferred portfolio ranging from 3.5% to 7.0%. Given that the preferred portfolio was within 4% of the lowest cost 2016 IRP portfolio (CCGT, an additional simple cycle turbine, and delayed renewables), that means the gas conversion portfolios ranged anywhere from 8-12% higher than the lowest cost portfolio.

H. Estimated Cost of CCGT and RFP Process.

i. Vectren South. Mr. Games testified that, consistent with the 2016 IRP results, the 2017 IRP Update, and the Pace risk analysis, Vectren South is proposing to build a CCGT with 700 MW of baseload capacity and 150 MW of peaking capacity to replace retiring coal-fired capacity. Mr. Games testified Vectren South is proposing to build a unit with an output of approximately 850 MWs in order to hold some additional capacity to meet its obligations as a public utility, as well as to serve potential new customers and foster economic development. The 850 MW replaces 865 MW of retiring capacity (730 MW of baseload and 135 MW of peaking capacity, including Broadway Unit 2 in 2025). Mr. Games further testified the estimated cost of the CCGT is $781 million (+/-10%). The estimate includes owner's costs and allowance for funds used during construction ("AFUDC"). This figure was based on cost estimates developed by witness Diane M. Fischer, Central Regional Area Director and Associate Vice President with Black & Veatch. Those estimates were derived from a request for proposals for all equipment comprising the CCGT as well as construction. Mr. Games testified Vectren South is proposing to construct the new CCGT on its existing A.B. Brown generating site which will provide a conservative cost savings of $50 million resulting from reusing the existing site, facilities and equipment. He explained the critical timing of the in-service date of the CCGT which will be operational for the 2023/2024 MISO capacity year in order to retire the Culley 2 and A.B. Brown units and thereby avoid material capital investments otherwise required to operate those units beyond 2023. Similarly, the Warrick Unit 4 joint operating agreement will terminate at the end of 2023. To continue to operate Warrick would also require further investment to comply with environmental regulations.

Mr. Luttrell testified regarding the other replacement generation options Vectren South considered. He described the solicitation of competitive bids for either purchased power or ownership of all or a portion of a new CCGT unit. Mr. Luttrell explained Vectren South engaged Burns & McDonnell to manage the entire power supply RFP process, and testified this process allowed Vectren South to compare the best competitive offers for dispatchable baseload capacity to several self-build alternatives, including a partnership alternative. Mr. Luttrell testified that based on this economic and qualitative comparison, Vectren South made the decision to pursue building the duct-fired version of the proposed CCGT at the existing A.B. Brown site.

Mr. Lind testified in greater depth regarding Burns & McDonnell's role in developing and managing the RFP process to address Vectren South's power supply needs. He testified Vectren South received 11 unique proposals from six different developers. He further testified each of the conforming proposals was ranked and the top two proposals were compared with Vectren South's self-build proposals. Mr. Lind testified that based on NPV cost and qualitative risk factors, including a congestion analysis related to an off-system generation project developed by a third party, Vectren South determined that the self-build option was the best resource for reliable, long term service.

ii. OUCC. Witness Alvarez testified that, while Vectren South conducted an RFP, Vectren South did not competitively bid the actual CCGT it seeks to build in this case. OUCC witness Aguilar testified that Vectren South has not yet identified a manufacturer, chosen an exact type of CCGT, or issued any bids for the project.

iii. Coal Parties. ICC witness Medine criticized Vectren South's RFP process for a number of reasons, including the contention that Vectren South was involved in the process and the self-build project did not submit a bid as part of the RFP process. ICC witness Hayet stated a similar concern. Ms. Medine also disagreed with the position that self-build projects represent less risk than merchant projects. Ms. Medine further testified regarding the risks associated with self-builds, including cost over-runs. She testified that most if not all new Indiana plants have experienced cost over-runs that utilities look to customers to recover, and unless Vectren South is willing to guarantee costs, this is a risk that should be considered.

iv. Joint Intervenors. Witness Comings testified Vectren South did not facilitate a competitive bidding process, which limited resources and discouraged bidders from offering purchased power agreements ("PPAs"). He further testified the RFP should not have been limited to MISO Zone 6 and should have been similar to other investor-owned utility solicitations.

v. Vectren South Rebuttal. Mr. Luttrell responded to the Intervenors' criticisms of Vectren South's RFP process. With respect to Mr. Comings' criticisms that Vectren South did not facilitate a competitive bidding process, including limiting resources and discouraging bidders from offering PPAs, Mr. Luttrell testified Vectren South is retiring over 70% of its baseload capacity and the RFP was specifically designed to fill that deficiency with reliable cost-effective supply identified by the IRP. Mr. Luttrell further testified PPAs were not discouraged and all four of the responsive bidders offered a PPA. Mr. Luttrell also responded to Ms. Medine's criticisms that Vectren South was involved in many aspects of the solicitation and that Vectren South did not submit a bid as part of the RFP Process. Mr. Luttrell testified Vectren South used two separate teams—one focused on the RFP and evaluation and one focused on developing the cost estimate for the Vectren South-build CCGT—and each of these teams were separate and walled off from the other. He testified Vectren South's involvement in the RFP process was critical to help ensure the RFP would meet the needs its modeling indicated was necessary. He further testified he did not believe the RFP process was negatively impacted as a result of the self-build alternative being developed parallel to the evaluation of the RFP bids, and Ms. Medine acknowledges "there is no evidence that there was inappropriate information transfer." Mr. Luttrell explained that ultimately, an evaluation of congestion costs associated with the off-system resource proposal was the driver of selecting the CCGT project at A.B. Brown as the best option.

Mr. Luttrell also responded to Ms. Medine's position that a PPA does not pose a greater risk than having a regulated utility own the generation facility. Mr. Luttrell testified that Vectren South believes that an on-system project at an existing utility site subject to regulatory oversight and financed by a public utility, is less risky than relying on a developer. He further testified that when 70% of baseload capacity is at stake, a utility should consider all risks to project completion and to ongoing service in the long term. Mr. Luttrell provided a real-life, recent example of the risks associated with relying on a developer to construct a project. Further, Mr. Luttrell testified that a PPA does represent greater risk compared to a self-build option because the financing, construction, operation, and future financial stability of the seller is not in control of either the regulated public utility or the Commission. Mr. Lind also explained that while the cost estimate for the CCGT is stated at plus/minus 10%, the risk is actually higher (plus/minus 50%) for all portfolios that do not include the CCGT.

I. Construction of Gas Lateral to Serve CCGT.

i. Vectren South. Mr. Perry Pergola – Director, Gas Supply – testified regarding Vectren South's decision to secure the interstate pipeline services of Texas Gas Transmission ("TGT") to provide natural gas service to the proposed CCGT. He testified Vectren South selected TGT because it was the least cost pipeline option to serve the CCGT at the A.B. Brown location. Mr. Pergola further testified Vectren South will build and operate a new gas lateral to interconnect with TGT and serve the CCGT.

Mr. Steve Hoover – Director of Engineering – testified regarding the 23 mile gas lateral Vectren South will construct to connect the CCGT with TGT. He testified Vectren South will construct the pipeline itself because, by virtue of its experience building, operating and maintaining new or existing gas facilities in the Vectren South service area, Vectren South is uniquely qualified and positioned to construct the new pipeline. Mr. Hoover further testified the estimated cost to construct the gas pipeline is approximately $87 million. This is not included in the estimated cost of the CCGT as presented by witnesses Fischer and Games, as it is expected the costs of the gas pipeline will be reflected in the delivered cost of the gas.

ii. OUCC. OUCC witness Alvarez testified regarding Vectren South's proposal to build the gas lateral to serve the CCGT. He testified Vectren South did not include the costs necessary to build the gas lateral in the $781 million CCGT cost estimate and should have.

iii. Industrial Group. Industrial Group witness Gorman also testified regarding Vectren South's proposal to construct a gas lateral to serve the proposed CCGT. Mr. Gorman testified Vectren South's proposal to self-build the gas lateral is not consistent with protecting the public interest and is anti-competitive. He testified that Vectren South should have considered a third party or TGT to develop the gas lateral. Mr. Gorman testified that to the extent TGT can construct a gas lateral at a lower cost than the Vectren South self-build option, then this option should be adopted. Mr. Gorman further testified that Vectren South's proposal to recover the pipeline costs as part of the fuel costs for the CCGT is not reasonable because the fixed cost to build the gas lateral will not vary with energy generation or volume of gas delivered to the CCGT. He testified instead it would be appropriate to allocate the gas lateral cost as part of the CCGT fixed capital cost of the facility and allocate it on a capacity basis.

iv. Coal Parties. ICC witness Medine testified regarding Vectren South's proposal to construct the gas lateral. Ms. Medine characterized Vectren South's proposal as a proposal to build the lateral using an affiliate without competitive bidding. She also criticized Vectren South's decision to self-build the gas lateral instead of soliciting bids from third parties. Ms. Medine testified that Vectren South did not solicit bids for the lateral from third parties, and, therefore, it cannot represent that it was the lowest cost option for the construction of the lateral.

v. Vectren South Rebuttal. Vectren South witness Steve Hoover responded to criticisms raised by the Intervenors related to Vectren South's proposal to construct the gas lateral. Mr. Hoover testified that Ms. Medine's characterization of the proposal as an "affiliate transaction" has no bearing on the overall substance of the proposed transaction because there are many reasons why it is advantageous for Vectren South to construct the gas lateral. He reiterated that the Vectren South engineering, land services, and construction management teams have already successfully completed two similar projects to deliver gas to Duke Edwardsport and IPL Eagle Valley generating units. He testified it is therefore in the best interest of Vectren South's customers for it to enlist the experience and expertise of its gas utility in the pipeline construction and operations. Mr. Hoover also responded to criticisms raised by witnesses Gorman and Medine that the lateral project is anti-competitive and being conducted without competitive bidding. Mr. Hoover testified that Vectren South requested TGT to provide a cost estimate to construct the lateral early in the process, and TGT's cost estimate was 10-15% higher than Vectren South's estimate. He further testified that Vectren South will complete a competitive procurement process to select a contractor to construct the lateral. Mr. Hoover testified that during the course of bidding and the evaluation process, Vectren South will also incorporate cost protections and performance incentives to ensure both competitive and fair pricing.

Mr. Hoover also responded to Mr. Gorman's preference that the lateral be placed in Vectren South's rate base as opposed to the costs being recovered via the Fuel Adjustment Clause ("FAC"). Mr. Hoover testified that like IPL and Duke, Vectren South has chosen to have a qualified local distribution company ("LDC") own and operate its gas delivery pipeline. Therefore, the pipeline will not be an electric utility asset and the costs associated with it will be recovered through gas rates.

As to the allegation that Vectren South's owning the gas pipeline as a gas utility asset is anti-competitive, witness Pergola testified on cross-examination that nearly all of the pipeline (more than 22 of the 23 miles of length) is located in Kentucky and therefore presents no opportunity for bypass, because Vectren South does not possess the right to serve customers in Kentucky.

J. Warrick Unit 4.

i. Vectren South. Mr. Wayne Games testified regarding the uncertain future of Warrick Unit 4. Mr. Games explained that Vectren South and Alcoa co-own the unit pursuant to a Joint Operating Agreement ("JOA") whereby each has 50% ownership in the unit. Mr. Games testified that while Warrick Unit 4 will continue to operate in the near term, the long term outlook for the unit is uncertain. He testified the future of the unit is tied to the Alcoa industrial site, and at any time Alcoa could decide to close the smelter unit, which utilizes significant quantities of electricity produced by Warrick Unit 4, based on price volatility in the aluminum market. He testified that the decision to shut down the smelter unit would jeopardize the future of Warrick Unit 4 and this uncertainty makes it difficult to justify investment in the unit or to depend upon it in the long run.

Vectren South witness Carl Chapman also testified regarding the future of Warrick Unit 4. Mr. Chapman testified that Vectren South has agreed to retain its involvement in the unit through 2023 to support the re-opening of the Alcoa smelter. However, he testified beyond 2023 it does not makes sense to continue to invest in a unit that could be subject to shut down if Alcoa decides it has no continuing need for the capacity.

ii. OUCC. OUCC witness Aguilar testified regarding Warrick Unit 4. Ms. Aguilar testified she does not agree with Vectren South's assessments of the risk of continuing to operate Warrick Unit 4 under the JOA and she disagrees with Vectren South's "presentation of the agreement." She further testified that Vectren South could continue to operate Warrick Unit 4 beyond 2023 with environmental compliance updates.

iii. Vectren South Rebuttal. Mr. Games responded to OUCC witness Aguilar's contention that Vectren South could continue to operate Warrick Unit 4 beyond 2023. He testified that due to compliance requirements coming in Alcoa's next National Pollutant Discharge Elimination System ("NPDES") permit, it is anticipated that the unit will require significant capital investment to meet environmental standards in the future. He testified that these investments coupled with the uncertainty related to whether Alcoa will continue to operate Warrick Unit 4[3] under the JOA and performance issues at the unit, warn against continued reliance on Warrick Unit 4.

Mr. Chapman also testified regarding the continued operation of Warrick Unit 4. He testified that the partnership with Alcoa jointly to operate Warrick Unit 4 has become highly uncertain in terms of duration and no longer represents a viable long-term resource option. Mr. Chapman further testified that while Vectren South's IRP recommended retirement of Warrick Unit 4 well before 2023, Vectren South examined each of the coal units to determine whether such units should be retained. He testified that while Culley 3 and Warrick Unit 4 had better profiles in terms of environmental equipment as compared to Vectren South's other units, Culley 3 ultimately had a better operating history based on cost, availability and heat rate. Mr. Chapman reiterated that a strike against continued operation of Warrick Unit 4 is the uncertainty surrounding the longevity of the Alcoa partnership. He reiterated the continued operation of Warrick Unit 4 is dependent on the aluminum market, and if Alcoa's industrial operations cease at the site, the environmental requirements facing Warrick Unit 4 will become significantly more stringent. Mr. Chapman ultimately testified the bottom line is assuming Warrick Unit 4 can continue on post-2023 presents great risk.

As noted previously, in response to our Docket Entry question seeking additional modeling of a portfolio with delayed retirement of Warrick Unit 4, Vectren South indicated that an additional capital investment cost of as much as $50 million may be required to retain the unit if IDEM determines not to renew a variance in the unit's current NPDES permit that allows water discharge at a higher temperature. The new draft renewal NPDES permit allows IDEM to terminate this variance at any time, which will likely require the construction of a cooling tower. Coupled with both Alcoa's and Vectren South's ability to terminate the joint operating agreement, this even further increases the risk of reliance on Warrick Unit 4 beyond 2023.

K. Culley Unit 3. While making investments to preserve some coal-fired generation is not part of the lowest NPV under the 2016 IRP modeling, Vectren South proposes to make investments at Culley Unit 3, its most efficient plant, in order that it may continue to operate beyond 2023. This decision became part of the preferred portfolio as a result of the risk assessment in the 2016 IRP. Preserving Culley Unit 3 promotes greater diversity in fuel sources and it also lessens the impact on the local coal industry. Witness Retherford described the environmental controls that are needed as a result of CCR and ELG. The Culley 3 Compliance Projects consist of (1) conversion of the current wet bottom ash collection system to a dry handling bottom ash system; (2) installation of a spray dryer evaporator system; and (3) the closure of the Culley West ash pond and construction of a new lined process water and storm water retention pond in its place. This new retention pond will be constructed on the location of the existing ash pond due to space limitations. Witness Fischer developed the cost estimates for the former two and Ms. Retherford provided the cost estimate for the latter. Recovery of the associated costs through a rate adjustment mechanism under Ind. Code ch. 8-1-8.4 was opposed by OUCC witness Aguilar and Industrial Group witness Gorman.

[3] With proper notice, Alcoa can also terminate the JOA.

4. Pending Summary Judgment Motion and Motion to Dismiss under T.R. 41(B). On July 19, 2018, the Coal Parties, Joint Intervenors, Evansville Western Railway, the OUCC, and the Industrial Group filed a Motion for Summary Judgment asking the Commission to vacate the schedule, arguing that we cannot grant Vectren South's request for authority to construct facilities until we have completed a "final" statewide analysis pursuant to Ind. Code § 8-1-8.5-3(a). Alternatively, the Movants asked us to grant them an extension of time to file their pre-filed testimony until at least 45 days after we post a "final" statewide analysis. We took the matter under advisement. At the conclusion of Vectren South's case-in-chief, Alliance Coal made an oral motion to dismiss under T.R. 41(B) on the same grounds. The T.R. 41(B) motion was joined by the OUCC and all of the other Movants except the Industrial Group and Evansville Railway.

In construing a statute, we start with its plain language and "attempt[] to give words their plain and ordinary meanings." *Indiana Wholesale Wine & Liquor Co., Inc. v. State ex rel. Indiana Alcoholic Beverage Com'n*, 695 N.E.2d 99, 103 (Ind., 1998) (citations omitted). "[I]n seeking to give effect to the legislature's intent, [the court] read[s] an act's sections as a whole and strive[s] to give effect to all of the provisions so that no part is held meaningless if it can be reconciled with the rest of the statute." *Fort Wayne Patrolmen's Benev. Ass'n, Inc. v. City of Fort Wayne*, 903 N.E.2d 493, 497 (Ind. Ct. App., 2009) (citation omitted).

The Motion is based primarily on Section 3(a) of Ind. Code § 8-1-8.5, which provides that "[t]he Commission shall develop, publicize, and keep current an analysis of the long range needs for expansion of facilities for generation of electricity," and Section 3(c), which provides that "[t]he commission shall consider the analysis in acting upon any petition by any utility for consideration." The Movants interpret these provisions to mean that we cannot consider a certificate of public convenience and necessity ("CPCN") request absent a "final" statewide analysis. We disagree.

Neither provision requires or implies there must be a "final" or conclusive statewide analysis. Nor does any other provision in Chapter 8.5. Section 3 directs us to undertake an "analysis" that is subject to ongoing review and revision. An analysis that must remain "current" cannot possibly remain static or culminate in a finished product. We find that the analysis detailed in the draft and final versions of the Statewide Analysis meets the requirements of the statute.

To the extent the Movants argue that we cannot grant Vectren South's Petition until we complete our annual report on the analysis, their Motion also fails.

Section 3(h) requires us "[e]ach year" to "submit to the governor and to the appropriate committees of the general assembly a report of its analysis regarding the future requirements of electricity for Indiana or this region." Ind. Code § 8-1-8.5-3(h). Section 5(b)(2) provides that a certificate may be granted if the Commission finds the project (A) "will be consistent with the Commission's analysis (or such part of the analysis as may then be developed, if any)"; or (B) is "consistent with a utility's specific proposal submitted under Section 3(e)(1) of this chapter and approved under subsection (d)." Ind. Code § 8-1-8.5-5(b)(2)(A) and (B).

This unambiguous language reflects the Legislature's understanding that new generation needs may arise at a time while the analysis or even the annual report is being developed or under revision. The Legislature granted the Commission authority to issue a CPCN rather than hold the request in abeyance until the annual report is issued.

It must be presumed that "'the legislature intended the language used in the statute be applied logically and not to bring about an unjust or absurd result.'" *D.B. v. Review Bd. of Indiana Dept. of Workforce Development*, 2 N.E.3d 705, 710 (Ind. Ct. App., 2013) (quoting *Penny v. Review Bd. of Ind. Dep't of Workforce Dev.*, 852 N.E.2d 954, 960 (Ind. Ct. App., 2006), trans. denied). Reviewing bodies also avoid "interpreting a statute in such a manner as to render its provisions mere surplusage." *Id.* (citing *In re Adoption of D.C.*, 887 N.E.2d 950, 959 (Ind. Ct. App., 2008). The Legislature cannot have meant for the Commission to hold off assessing petitions until its analysis becomes "final" (which will never occur), or even until its annual report is submitted. Thus, the statute is clear that in considering a CPCN request, pursuant to Section 5(b)(2) we can rely on whatever current statewide analysis exists or simply determine whether the proposal is consistent with the utility's own plan and reports.

In sum, the Commission retains authority to review a project at any time. Ind. Code § 8-1-8.5-5.5 expressly allows us to "commence a review of any certificate granted under this chapter" when, "in the opinion of the commission, changes in the estimate of the probable future growth of the use of electricity" call for such review. Further, "[i]f the commission finds that completion of the facility under construction is no longer in the public interest, the commission may modify or revoke the certificate." Id.

For all of the foregoing reasons, and each of them, the Motions for Summary Judgment and for Dismissal under T.R. 41(B) are denied.

5. Commission Discussion and Findings.

A. Vectren South's Request for a CPCN for a CCGT. Vectren South requests a CPCN for a proposed CCGT (approximately 850 MW) to be constructed at the current site of the A.B. Brown power plant in Posey County. Under Chapter 8.5, a public utility may not begin the construction, purchase or lease of any steam, water, or other facility for the generation of electricity to be directly or indirectly used for the furnishing of public utility service without first obtaining from the Commission a certificate that public convenience and necessity requires, or will require, such construction, purchase or lease.

In considering a CPCN request, Chapter 8.5 requires the Commission to consider options other than the construction, purchase, or lease of an electric generating facility. *See* Ind. Code § 8-1-8.5-4.

Further, Ind. Code § 8-1-8.5-5 sets forth specific findings the Commission must make in order to approve and grant the requested CPCN. First, the Commission must make a finding, based on the evidence of the record, as to the best estimate of construction costs. Second, the Commission must find that either (a) construction will be consistent with the Commission's Statewide Analysis, if any, for the expansion of electric generation facilities, or (b) the proposed construction is consistent with a utility-specific proposal as to the future needs of consumers in the State of Indiana or in the petitioning public utility's service area [i.e., the utility's IRP]. Third, the Commission must find that public convenience and necessity require the facilities for which the CPCN is requested.[4]

[4] A fourth finding relating to coal-consuming facilities, pursuant to Ind. Code § 8-1-8.5-5(b)(4), does not apply to the proposed natural gas facilities.

"We have indicated in previous CPCN cases that 'least-cost planning' is an essential component of our [CPCN] law." *Joint Petition of PSI Energy, Inc. and CINCAP VII, LLC*, Cause No. 42145, at 4 (IURC Dec. 29, 2002), *quoting Southern Indiana Gas & Electric Co.*, Cause No. 38738, at 5 (IURC Oct. 25, 1989). "We have defined 'least-cost planning' as a 'planning approach' which will find the set of options most likely to provide utility services at the lowest cost once appropriate service and reliability levels are determined." *Id.* "However, we have emphasized that the [CPCN] statute does not require the utility to automatically select the least cost alternative. Nor does the statute require the utility to ignore its obligation to provide reliable service or to disregard its exercise of reasonable judgment as to how best to meet its obligation to serve." *Id.* As this Commission has previously ruled: "[i]f an Indiana utility reasonably considers and evaluates the statutorily required options for providing reliable, efficient, and economic service, then the utility should, in recognition that it bears the service obligations of IC 8-1-2-4, be given some discretion to exercise its reasonable judgment in selecting the option or options to implement which minimize the cost of providing such service." *PSI Energy, Inc.*, Cause No. 39175, at 14 (IURC May 13, 1992); *see also Joint Petition of PSI Energy, Inc. and CINCAP VII, LLC*, Cause No. 42145, at 4.

The pre-approval of long-lived power plant investment and the concurrent regulatory assurance of that investment's recovery is, at its base, the creation of fixed costs that customers will be required to pay several years into the future, perhaps as long as 30 years or more into the future. Accordingly, our consideration in this and other pre-approval requests, especially in periods of seemingly quickening technological change, must not ignore the risk that any such investment may become uneconomic over the long-term. We must acknowledge that the economic forces at work may come from other supply side options or even demand side opportunities. The supply side and demand side certificating statutes implicate this by recognizing that an optimal balance of energy resources should consider both aspects in meeting customer needs.[5] A complication in the optimizing effort is the often disparate time horizons of the supply and demand sides of the balance. The inability to adjust the long-lasting nature of the supply side of the equation in the event market conditions or demand side expectations change in a lesser time horizon introduces a risk that some measure of the supply side investment may become uneconomic within its lifetime.[6] Demand side efforts by customers as a result of the uncontroverted improving economics of customer-scale generation resources may further compound the challenge of the optimal balancing act. Reducing demand in the near term does not necessarily correspond with reduced assured supply side investment cost recovery.[7] Because unwinding assured cost recovery should an asset become uneconomic is not a commonly employed regulatory option, it is prudent to ensure during the pre-approval process that we understand and consider the risk that customers could sometime in the future be saddled with an uneconomic investment. Outcomes that reasonably minimize such potential risk and serve to foster utility and customer flexibility in an environment of rapid technological innovation on both the utility and customer side of the meter are, therefore, a lens through which we will review Vectren South's request.

[5] Indiana Code §§ 8-1-8.5-4 and -10(c)(3).

[6] This effect can be see through the recovery of lost revenues a statutory component of utility DSM programs, which is in part a function of investment, of fixed cost, that is not being consumed at the expected rate.

[7] This timing inconsistency can reduce the value of demand side efforts because they are not avoiding long-lived fixed costs previously approved and included in rates. The full incremental impacts of demand side actions which occur after the approval of long-lived fixed costs are only affected over longer periods of time when future resources must be acquired and the timing and type of resource might change as a result of cumulative demand side activities.

i. Ind. Code §§ 8-1-8.5-4.

(1) Ind. Code § 8-1-8.5-4(1). In evaluating a utility application for approval to construct new generation, the Legislature has directed us to take into account the utility's "current and potential arrangements with other electric utilities for (A) the interchange of power; (B) the pooling of facilities; (C) the purchase of power; and (D) joint ownership of facilities."

As a member of MISO, Vectren South interchanges power on a daily basis, and Vectren South's modeling considered and factored this arrangement into its decision to seek a CPCN. In addition, early in its resource selection process Vectren South identified a potential partner for a joint generation project. Witness Luttrell explained that this partner was interested in owning a minority share of a larger CCGT, and agreed to study locating such a unit on Vectren South's system. As studies ensued, the partnership appeared to be a viable resource option. As a result, the parties studied this joint ownership opportunity throughout 2017, but ultimately in January 2018 the potential partner provided notice that it would not proceed with such a project. Both Vectren South and the Commission have considered the interchange of power and pooling of facilities.

When assessing a CPCN petition, the Commission also considers the potential purchase of power by Vectren South. On June 20, 2017, Vectren South issued a RFP for dispatchable resources located in MISO Zone 6. Vectren South explained that its RFP specified this location requirement in order to satisfy MISO's requirement that a load serving entity have at least 67% of its resources located within its zone. The RFP sought dispatchable resources based upon the 2016 IRP analysis, which recommended that Vectren South retire nearly all of its baseload coal-fired capacity by the end of 2023. As a result, the RFP was designed to solicit baseload capacity to replace the 730 MWs provided by the retiring coal units. In response, Vectren South received nine qualified bids offering both PPAs and offers to build a CCGT and sell that unit or a partial interest in that unit to Vectren South. Using the expertise of Burns & McDonnell ("BMC"), Vectren South evaluated both quantitative and qualitative aspects of the competing bids. Based on BMC's analysis of the levelized cost of energy ("LCOE") of the bids, Vectren South selected the bid with the most favorable LCOE to compare to a self-build option. BMC's analysis was that Vectren South's self-build option had a better net present value than this best bid, and also exposed Vectren South to less risk versus long-term reliance on a merchant developer. Vectren South's rebuttal testimony noted that the merchant developer in question had in fact, even prior to its bid submission, withdrawn its project from the MISO queue without informing Vectren South.

The Commission acknowledges Vectren South's issuance of an RFP but believes the RFP was unduly restrictive given the rapid changes in technology and costs being seen in the market, especially regarding renewable energy. The narrow RFP with its focus on a large baseload dispatchable resource limited the options Vectren South evaluated to those larger than 600 MW. As a result, Vectren South foreclosed consideration of combinations of smaller resources that might have offered greater resource diversity, flexibility and cost efficiencies than reliance on the acquisition of a single large natural-gas facility. As discussed further below, expansion of the RFP to consider a broader spectrum of resource options would have also gone a long way to improve the metrics to limit risks from exposure to changes in market conditions and technologies.

Based on Vectren South's unduly restrictive RFP the Commission cannot conclude that Vectren South thoroughly evaluated the purchase of power in connection with Vectren South's request.

(2). Ind. Code § 8-1-8.5-4(2).

(a) The Refurbishment of Existing Facilities. In acting upon a petition for the construction of an electric generation facility, we must consider other methods for providing reliable, efficient, and economical electric service, including the refurbishment of existing facilities. Ind. Code § 8-1-8.5-4(2). Ms. Aguilar summarized the following alternatives that Vectren South failed to fully analyze: (1) Retain Coal at Vectren South's existing plants and invest in refurbishments; (2) Retain the agreement with Alcoa for Warrick Unit 4; (3) Refuel the A.B. Brown unit(s) with gas; (4) A blended option, such as refueling one or more A.B. Brown units to gas and building a smaller CCGT; (5) Enter into a PPA with one of the bidders who responded to Vectren South's RFP; and (6) Retain its Broadway Avenue Unit 2. Pub. Ex 1, p. 8. Ms. Aguilar argued that Vectren South unfairly screened out these alternatives during the IRP process.

We agree with Ms. Aguilar and Dr. Boerger that Vectren South did not fully consider options to extend the life, or refurbish, existing units as required by Ind. Code § 8-1-8.5-4(1). *Id.* and Pub. Ex. 3, p. 6. This failure began during Vectren South's IRP process, when Vectren South screened out, without further study, viable refurbishment options. Pub. Ex. 1, p. 11. Vectren South's stated reason for shutting down the A.B. Brown units is premised on the need to replace the flue-gas desulfurization ("FGD") units at a cost of approximately $350 million. Pub. Ex. 3, p. 7. Dr. Boerger stated that with the exception of the current FGDs, the units operate quite well and are sized appropriately for a small utility like Vectren South. But as noted by Ms. Aguilar and Dr. Boerger, Vectren South's chosen FGD replacement technology was the most expensive and only technology reviewed. *Id.,* Pub. Ex. 3. Dr. Boerger pointed out that Vectren South did not consider lower-cost FGD replacement options, even though such options were available. He said that this decision made the continued use of the A.B. Brown units look less attractive in modeling than if those options had been included. A reasonable alternative would have been the refurbishment of these units through refueling. Pub. Ex. 3, p. 7. Refueling is viable, proven technology that could be accomplished at a fraction of the price of the CCGT – approximately $45 million for both A.B. Brown units.

Vectren South considered a smaller 440 MW CCGT option in its last IRP, but Vectren South did not include it as part of any refueling options. Pub. Ex. 3, p. 9. Further, when Vectren South issued its RFP, it did so for 600-800 MW of dispatchable power, precluding smaller units that might have combined with refurbishment of other Vectren South units. Tr. B-25 - B-26. Vectren South did not fully model the conversion of one of the A.B. Brown units in its rebuttal testimony. Tr. E-45 – E-46.

On cross-examination, Vectren South witness Mr. Swiz estimated that the value of the stranded assets at the A.B. Brown unit alone will equal $220 million and that the system-wide total will be $270 million. While Vectren South argues that the CCGT option is the lowest cost, we find for the many reasons stated throughout this Order, including Vectren South's failure to sufficiently consider the refurbishment and continued operation of its existing facilities, we are not able to verify this claim. Through the lens of minimizing risk and providing future flexibility the refurbishment option would seem to provide a potential bridge to the future, providing system capacity value that was not sufficiently evaluated. This conservative solution and risk avoidance strategy stands in stark contrast to proposed CCGT. Vectren South plans to submit a new IRP in 2019. We instruct Vectren South to closely consider our analysis in this Order and the Director's Report on the 2016 IRP of the flaws in their modeling for the 2016 IRP and the 2017 IRP Update and to present a more thorough analysis that fully evaluates all possible options for continuing to provide reliable, efficient, and economical electric service.

(b) Conservation and Load Management. The evidence demonstrates that Vectren South has evaluated the CCGT against other reasonable generation alternatives, and included demand side management and energy efficiency ("DSM/EE") levels consistent with the targets approved in Cause No. 44927. Vectren South's modeling concludes that, even when the cost of energy efficiency has been significantly lowered, the CCGT is still the least cost reliable resource alternative to meet Vectren South's customers' future energy resource needs.

The Joint Intervenors criticize the assumptions used by Vectren South to model the cost of DSM/EE, arguing that the assumptions used by Vectren South were too high resulting in a higher cost of DSM/EE. Ms. Harris stated in her rebuttal that for purposes of this proceeding, Vectren South opted only to update its growth factors in its revised cost analysis in order to show the impact lower DSM/EE costs would have on the energy resources selected in its IRP. Ms. Harris explained that limiting the updates to the growth factors preserved the integrity of Vectren South's 2016 IRP. Petitioner's Exhibit No. 8-R, p. 3. We find that while some of the cost assumptions used by Vectren South could have been updated, on the whole it does not render Vectren South's analysis of DSM/EE unreasonable.

(c) Cogeneration and Renewable Energy Sources. Vectren South's IRP modeling process considered the potential for cogeneration facilities to serve its customers and adjusted its load forecast to reflect the potential for cogeneration facilities. Petitioner's Exhibit No. 5, Attachment MAR-1, pp. 99-103. Consequently, the potential for customer-owned generation resources, including renewable generation, to reduce Vectren South's load was evaluated as part of the IRP process that concluded the CCGT was necessary as part of least-cost planning. Nonetheless, while Vectren South may have considered renewable energy in the IRP, there is a lack of evidence that Vectren South made a serious effort to determine the price and availability of renewables. In addition, the economics of customer-scale renewable and cogeneration facilities appears likely to continue to improve and we anticipate that additional well-developed efforts to understand their customers' interest would serve to provide clarity to the lens of risk avoidance by minimizing the potential for unexpected demand side efforts. Therefore, we would expect Vectren South to ensure an enhanced consideration of renewable energy and customer-generator opportunities in future IRPs.

(3) Ind. Code § 8-1-8.5-5. A certificate may be granted only if the Commission makes the followings findings:

(a) Best estimate of construction, purchase, or lease costs based on the evidence of record. The cost estimates for Vectren South's proposed CCGT were developed and presented by witness Diane Fischer. Black & Veatch developed a design basis and conceptual design and thereafter developed a cost estimate. Several conceptual designs were first developed. From that, ten plant alternatives for purposes of estimating costs were identified. This was later narrowed to seven alternatives for which detailed costs were developed. Competitive bids were obtained for the equipment and materials. Based upon Black & Veatch's experience as an engineering, procurement and construction ("EPC") contractor, Black & Veatch was able to estimate indirect costs, contingency, overhead, and profit for the EPC contractor. Bids were also received for construction. Ultimately, Ms. Fischer testified that the cost estimate for the proposed CCGT had been refined to +/- 10%. The total estimated project cost (excluding owner's costs) was $582,000,000. The owner's costs were then provided by witness Games, including insurance, contingency, study, and AFUDC. The total cost estimate was $781,000,000.

(b) Consistency of the CCGT with Vectren South's Utility-Specific IRP and the Statewide Analysis. Ind. Code § 8-1-8.5-5(b)(2)(A) directs the Commission to determine whether Vectren South's proposed construction of a new CCGT will be consistent with the Commission's 2018 Statewide Analysis. The final version of that report was issued after the parties' pre-filing deadline, but before the evidentiary hearing and was admitted into evidence as Pet. Admin. Not. Ex. 2. Included in that report is a synopsis of information taken from the most recent IRP projects of Indiana utilities, including Vectren South.

In Appendix 12 of the Statewide Analysis, the concept of Resource Diversity is explained:

> In an electric system, resource diversity may be characterized as utilizing multiple resource types to meet demand. A more diversified system is intuitively expected to have increased flexibility and adaptability to: 1) mitigate risk associated with equipment design issues or common modes of failure in similar resource types, 2) address fuel price volatility, and 3) reliably mitigate instabilities caused by weather and other unforeseen system shocks. In this way, resource diversity can be considered a system-wide tool to ensure a stable and reliable supply of electricity. Resource diversity itself, however, is not a measure of reliability. Relying too heavily on any one fuel type may create a fuel security or resilience issue because the level of resource mix diversity does not correlate directly with a resource portfolio's ability to provide sufficient generator reliability attributes.

Vectren South's proposal to concentrate its base load capacity from five different generating units located at three different sites down to just three generating units (one of them constituting 70% of Vectren South's baseload capacity) located at two sites appears to be contrary to the concept of resource diversity.

On page 5 of the 2018 Statewide Analysis it says:

> A key consideration in long-term resource planning is the need to retain maximum flexibility in utility resource decisions to minimize risks. An IRP developed by a utility should be regarded as illustrative and not a commitment for the utility to undertake.

In explaining the importance of sound long-range planning on page 56 of the 2018 Statewide Analysis, it says, "[t]he credibility of the analysis is critical to the efforts of Indiana utilities to maintain as many options as possible, which includes off ramps, to react quickly to changing circumstances and make appropriate changes in the resources." However, we find nothing in Vectren South's evidence convinces us that its proposal provides any off ramps that would allow Vectren South to react to changing circumstances and make appropriate changes in resources. To the contrary, Vectren South's proposal seems to close most off ramps for the foreseeable future.

The parties offered diametrically opposed views on the modeling offered to support the CPCN, with Vectren South pointing to its CCGT conclusion as consistent with its IRP. But that conclusion is but one part of the analysis. We have criticized utilities in the past for modeling infirmities and even penalized a utility for analysis we found lacking. In IPL's MATS case, we ordered a $10 million credit to customers to "send[] an appropriate message" to the utility. *Indianapolis Pwr. & Light Co.*, Cause No. 44242, 2013 WL 4479081 *38, 307 P.U.R.4th 311, Order p. 36 (IURC Aug. 14, 2013). We found IPL's cost/benefit study "disappointing" and noted our own "responsibility to insure that the regulatory process involves the presentation of the best evidence possible, given the facts and circumstances of a particular case." *Id.* at 35.

At the outset, Mr. Games testified that Vectren South sent a request for information ("RFI") to original equipment manufacturers ("OEM") for CCGT pricing information before Vectren South's 2016 IRP. Tr. E-89 – E-91. Mr. Chapman stated that under any of the IRP models, the CCGT is the least expensive. Tr. A-27 - A-28.

Dr. Boerger testified that Vectren South did not consider other viable options such as refueling and smaller combinations of generation assets to meet its needs, Pub. Ex. 3, p. 1 – p. 2, which would be more prudent for a small utility like Vectren South. Pub. Ex. 3, p. 5. Vectren South excluded possible options such as maintaining Culley 2, Pub. Ex. 3, pp. 11-12, and did not allow the refueling of the A.B. Brown units to be included in any of its model runs. *Id.* Vectren South kept a smaller, 440 MW CCGT from being combined with a refueled A.B. Brown unit. Pub. Ex. 3, p. 13. Mr. Games admitted that Vectren "never [ran] a risk analysis of portfolios including a 1 X 1 CCGT instead of a 2 X 1[.]" Tr. E-50. Vectren South also did not allow for proposals of joint projects to be built at it's A.B. Brown site, which would eliminate the potential for congestion problems Vectren South identified as a problem in its RFP responses. Vectren South's Strategist model limited the amount of capacity purchases that a given portfolio could make. Tr. D-73. This had the effect of automatically screening out PPAs that could have been combined with other resources to meet Vectren South's capacity needs. The Director's Report on Vectren South's 2016 IRP noted that Vectren South failed to model a wide range of gas prices, making the "range of fuel price projections… unduly limited[,]" Tr. D-85, and Vectren South's re-run of gas costs did not model higher prices in a wide enough range. Tr. D-86. As noted by Mr. Alvarez, Vectren South's model retired the BAGS 2 unit in 2024 without evidence of any engineering reason to do so. Pub. Ex. 2, pp. 13-14.

Dr. Boerger also found that Vectren South modeled the cost of its proposed CCGT to be $200 million less than the cost of the project presented in the testimony of Vectren South witness Games. Pub. Ex. 3, p. 2. The consequence of excluding $200 million in Vectren South's NPV calculation had the effect of making the CCGT option look more favorable. Pub. Ex. 3, p. 14. Without adding the $200 million back into the model runs, Vectren South's analysis is skewed. Pub. Ex. 3, p. 18 – p. 19. Mr. Games admitted that his testimony about the estimates was confusing, stating "[w]e started off with 2017 dollars, and those were -- then overheads were added, anticipated profit with the EPC, contingency for EPC, and escalation was added to get to the 582 million." Tr. E-15 – E-16. Mr. Lind took issue with Dr. Boerger's analysis, but admitted that Vectren South did not include $130 million in owner's costs when it compared its self-built CCGT to other options offered in the RFP and otherwise. Tr. A-36 – A-38; Tr. D-7 – D-8. When questioned why BMC did not use the $781 million figure, Mr. Lind stated that the $630 million estimate used for modeling was a +/- 50% estimate; the $781 million had a more certain +/- 10% range of accuracy. Tr. A-35; Tr. C-61 - C-62, C-74. BMC's projected cost of $580 - $650 million was used to weigh the economics of potential projects. Tr. A-

36 – A-38. And Vectren South witness Mr. Vicinus ran his "low regulatory" model using the $630 million estimate. Tr. D-98.

In response to the OUCC's criticism of its modeling, Vectren South's rebuttal included a new model run that refueled one of the A.B. Brown units, and added 200 MW of solar. Tr. D-12 – D-13. Vectren South used this rebuttal modeling to try to reinforce its original request for a 850 MW CCGT. Both Mr. Lind and Mr. Games acknowledged, however, that the addition of 200 MW of solar was not the best choice to meet MISO's PRM, because MISO would only give Vectren 100 MW of credit for the 200 MW of solar. Tr. E-15. The revised model also did not take into account the fact that solar costs between $1,200 - $1,800 per MW, Tr. D-16 – D-17, and Vectren South did not model any storage to counter the inherent intermittency of solar resources. Tr. D-14.

While we find Vectren South's request is "consistent" with its 2016 IRP, the subsequent modeling for this case effectively screened out multiple less-expensive alternatives. Vectren South did not allow its models to choose refueling or smaller units in combination. While Vectren South's rebuttal modeling runs included refueling of the A.B. Brown units in various configurations, the rebuttal modeling was not used to make Vectren South's decision of what generation form to choose. Tr. D-14. We view the rebuttal modeling as an after-thought used to buttress Vectren South's initial request.

Vectren South had sufficient time to conduct its analysis in a way more open to smaller-scale options that would correct the modeling deficiencies that have been identified. It seems straight-forward to suggest that smaller-scale options, especially for a relatively small electric utility, serve to minimize the risk should a challenge arise at any one option. As noted above, minimizing supply side long-term investment risk in an environment of rapid technological innovation is an attractive characteristic in a utility resource proposal. Vectren South should use its scheduled 2019 IRP process to address problems in its modeling, incorporate more options for partnering with other entities and competitive inquiries into smaller-scale options that can be acted upon swiftly to meet the end-of-2023 date upon which additional capacity may be needed.

(c) Public Convenience and Necessity. Ind. Code § 8-1-8.5-5(b)(2) requires that we find that public convenience and necessity requires or will require the proposed CCGT. Such consideration of the public interest is not only a statutory requirement at the outset but would become a continuing obligation should the Commission grant a CPCN. Ind. Code § 8-1-8.5-5.5 provides that if, after granting a CPCN for construction of a new generator, "the commission finds that completion of the facility under construction is no longer in the public interest, the commission may modify or revoke the certificate."

"[P]ublic interest may be taken to encompass a wide range of considerations, from environmental, health, and safety concerns, to the financial concerns of employers, employees, and ratepayers." *General Motors Corp. v. Indianapolis Power & Light Co.*, 654 N.E.2d 752, 762 (Ind. Ct. App., 1995). In *General Motors*, the court approved the Commission's consideration of the impact on employment in the coal industry in its public interest determination. *Id.*

The parties dispute whether Vectren South accurately and adequately evaluated risk in its analysis of alternative portfolios and selection of the proposed CCGT. As noted earlier, under Ind. Code § 8-1-8.5-4, we are required to take into account other methods for providing reliable, efficient, and economical service, and we find utility risk analyses play an important role in comparing alternative portfolios.

Joint Intervenors argued that Vectren South's risk analysis is inadequate for multiple reasons. Joint Intervenors note that the risk analysis has not been updated since the 2016 IRP, despite Vectren South having updated inputs available for several inputs, including the estimated cost of its preferred build, and adequate time to re-run the model. Joint Intervenors complain that Vectren South ignored known material risks in a manner that biased results in favor of its preferred portfolio, including taking a one-sided view of capacity purchase and market purchase risks and failing to consider the potential for future methane regulations. Joint Intervenors further argue that Vectren South arbitrarily scored several metrics and designed others to conceal rather than measure obvious risks of the preferred portfolio.

We find merit in several of Joint Intervenor's critiques and are further concerned that Vectren South has not fully responded to critiques in the Final Director's Report on the 2016 IRPs. We agree that Vectren South had adequate time and opportunity to update its risk analysis modeling prior to this filing, and that it has sufficient time to do so now before moving forward. Vectren South updated inputs in its possession for multiple factors, including: solar capital costs; variable production costs and revenue requirement assumptions for existing units; forecasted cost for wholesale market capacity and energy; delivered fuel prices for gas and coal; and costs associated with new energy efficiency programs. Pet. Ex. 6 at 9-10. Vectren South also had a higher capital cost estimate for its preferred build. We know Vectren South had time to use these inputs to re-run the model because (a) it did just that with some of its Strategist modeling and (b) Mr. Vicinus testified that it would have taken just three months to re-run the risk analysis modeling. Tr. p. D-66. Mr. Vicinus opined that updated risk modeling would not change the result, but we are skeptical given the number and import of the updated inputs and the significance of the proposed portfolio changes. *See Indianapolis Pwr. & Light,* Cause No. 44339, 2014 WL 2091348, Order p. 27 (IURC May 14, 2014) ("[W]e believe that IPL could have reasonably updated the [model] given the extent of changes in data inputs and assumptions and provided a more robust analysis."). Before proposing a portfolio change of this magnitude, Vectren South should have taken the three months necessary to update its risk analysis modeling. Updated risk modeling may not be necessary in all cases, but it is warranted here given the size and cost of the proposed CCGT.

We are further concerned that Vectren South appears not to have accounted for material risks associated with its preferred portfolio. As we have previously stated, "it is appropriate that modeling take into consideration reasonable risks and unknowns." *Indianapolis Pwr. & Light Co.*, Cause No. 44794, 2017 WL 1632316, Order p. 28 (IURC Apr. 26, 2017). Joint Intervenors point out that Vectren South's risk analysis took a one-sided view of capacity purchase and market purchase risks. *See* JI Ex. 2 at 43; Vicinus Rebuttal. Vectren South offered no rebuttal explaining its one-sided view of market risk, which assumed surplus capacity and generation offers only benefits to ratepayers. JI Ex. 2 at 20-21. That view of market purchases is only true when market prices and/or load are high. JI Ex. 2 at 21. Further, Vectren South's Docket Entry response of October 5, 2018, presents portfolio results that suggest the material weight at which opportunity sales influences the analysis.[8] Heavy dependence on market revenues to support a regulated investment choice is a speculative influence that we find must be materially discounted to limit the risk of customers being saddled with

[8] The submitted table indicates that the advantage of the Preferred Portfolio in comparison to (1) BAU to Gas Conversion escalates from 1.3% to 3.5% when the opportunity sales sharing moves from 50% to 100%.

uneconomic options should such speculation unfold differently than forecasted. A metric biased in favor of portfolios with surplus generation is speculation we decline to embrace.

Vectren South's own witnesses and others acknowledged risks related to relying on gas generation, but Vectren South only considered carbon dioxide emission reductions when it evaluated environmental risk. We agree that was too narrow an approach to environmental risk and one that biased the analysis in favor of gas-fired generation.

The Commission appreciates the metrics developed and used by Vectren South in the 2016 IRP, but we agree with the Joint Intervenors that the use of these particular metrics also obscured critical characteristics of the preferred portfolio. One of Vectren South's IRP objectives was to develop a plan with flexibility to adapt to market conditions and technological change to minimize risks to shareholders and customers. Specific metrics to measure resource portfolio balance and flexibility included concentration on one technology, the number of technologies and having resources remote from Vectren South's load. A critical piece of information these metrics overlook is that the acquisition of an 850 MW resource must be evaluated relative to the load to be served. Vectren South's 2016 IRP Base peak load forecast is for the summer peak to increase from 1,109 MW in 2019 to 1,198 MW in 2036. The acquisition of an 850 MW generation facility represents approximately 77 percent of the 2019 peak load and just under 71 percent of the summer peak load for 2036. We are hard pressed to see how reliance on one facility for so much of the Vectren South system requirements is consistent with maintaining flexibility to respond to changing market conditions and technological change.

Therefore, we conclude that Vectren South's risk analysis does not adequately consider the relative risk of other methods for providing reliable, efficient, and economical electric service. The proposed large scale single resource investment for a utility of Vectren South's size does not present an outcome which reasonably minimizes the potential risk that customers could sometime in the future be saddled with an uneconomic investment or serve to foster utility and customer flexibility in an environment of rapid technological innovation. As a result, we find that Vectren South has not demonstrated through the evidence of record that the public convenience and necessity require the building of an 850 MW CCGT. Therefore, Vectren South's request for a CPCN to construct a 850 MW CCGT is denied.

B. Vectren South's Request for a CPCN for Culley compliance projects and related relief. Vectren South's preferred portfolio also includes the construction of various environmental projects that Vectren South contends are needed so that Culley Unit 3 can continue to operate beyond 2023. Vectren South's petition seeks relief for these projects under Ind. Code ch. 8-1-8.4 as "federally mandated" projects.

i. Ind. Code ch. § 8-1-8.4 ("Chapter 8.4").

(1) Federally Mandated Requirements (Ind. Code §§ 8-1-8.4-5 and 8-1-8.4-6(b)(1)(A) and 8-1-8.4-7(b)(3)). Ind. Code § 8-1-8.4-5 defines a federally mandated requirement to include "a requirement that the commission determines is imposed on an energy utility by the federal government in connection with any of the following: (2) The federal Water Pollution Control Act (33 U.S.C. 1251 *et seq.*)" and also includes "(7) Any other law, order, or regulation administered or issued by the United States Environmental Protection Agency, the United States

Department of Transportation, the Federal Energy Regulatory Commission, or the United States Department of Energy."

The description of the Culley 3 Compliance Projects was set forth in the direct testimonies of Ms. Fischer and Ms. Retherford. The Culley 3 Compliance Projects consist of (1) conversion of the current wet bottom ash collection system to a dry handling bottom ash system; (2) installation of a spray dryer evaporator system; and (3) the closure of the Culley West ash pond and construction of a new lined process water and storm water retention pond in its place. This new retention pond will be constructed on the location of the existing ash pond due to space limitations. No party disputed that the dry handling bottom ash conversion or spray dryer evaporator system qualify as compliance projects to meet federally mandated requirements. The OUCC challenged whether the closure of the existing pond qualified for relief but did not contend that it was not federally mandated. For the reasons described below, we find that these projects all constitute compliance projects to meet federally mandated requirements as those terms are defined in Ind. Code §§ 8-1-8.4-2 and -5.

Vectren South witness Retherford testified that the dry handling bottom ash system is required to comply with the ELG Rule, which was promulgated under the federal Water Pollution Control Act. Petitioner's Exhibit No. 9, p. 11. The ELG rule prohibits further wet handling of fly and bottom ash. This system will enable ash from Culley Unit 3 to be disposed of in a landfill, hauled back to a surface mine in accordance with applicable surface mining regulation or recycled rather than being washed into the ash pond as part of a water discharge.

Ms. Retherford further explained that the spray dryer evaporator system was necessary to ensure compliance with ELG-imposed limits on FGD wastewater discharge. She noted that this system functions effectively as a ZLD system and enables Vectren South to utilize the alternative ELG-imposed compliance date of December 31, 2023, and to meet future more stringent ELG wastewater discharge limits.

Ms. Retherford testified that construction of a new, lined process and storm water retention pond is required to comply with the ELG Rule. As we have already noted, projects necessary to comply with the ELG Rule, promulgated pursuant to the federal Water Pollution Control Act (33 U.S.C. 1251 *et seq.*), constitute a federally mandated requirement. The only dispute, raised by OUCC witness Aguilar, pertains to Vectren South's plans to close the existing Culley West pond so that the new lined pond can be built at the site. Witness Retherford testified that there are two reasons the Culley West pond is closing: (1) the pond was taken out of service prior to the 2015 deadline and the CCR rule requires that it be closed by 2020; and (2) the current space limitations require that the new stormwater retention and process water pond be constructed on the current location. Thus, there is no dispute that costs associated with the construction of the new lined pond are incurred pursuant to a federally mandated requirement. The dispute is whether the costs to close the Culley West pond so that the new pond can be built on top of that location, also qualify as federally mandated costs.

The OUCC identifies three reasons closure costs for the Culley West pond should not be considered federally mandated costs. First, OUCC witness Aguilar contends that Vectren South has been collecting depreciation and asset retirement costs in base rates, which include the closure of ash ponds. Public's Exhibit No. 1, p. 28. However, Vectren South witness Retherford responded that finalization of the CCR rule on April 17, 2015 imposed more stringent requirements to close the ash pond. The CCR rule imposed an obligation to dewater, cap and/or remove ponded ash. Petitioner's Exhibit No. 9-R, pp. 24-25.

On rebuttal, Mr. Swiz stated Vectren South's existing depreciation rates include an estimated level of cost of removal that was designed well before the implementation of requirements to close the ponds in accordance with the environmental regulations described by Ms. Retherford. The assumed removal costs in the demolition study provided in Cause No. 43839 (Vectren South's most recent general rate case), estimated $1.1 million to close both of the Culley Ash Ponds based on cost of backfill, grading and seeding. By comparison, the estimate for closure of one ash pond in this proceeding is $19.969 million. Petitioner's Exhibit No. 13-R, pp. 6-7; Petitioner's Administrative Notice 1.

Consequently, we find that costs associated with CCR closure have not been included in Vectren South's depreciation rates, which were last updated prior to finalization of the CCR Rule.

Second, the OUCC contends that other utilities are not tracking pond closure costs as Federally-Mandated CCR Projects. Public's Exhibit No. 1, p. 28. Vectren South witness Swiz noted that no utility had proposed such recovery yet but that one utility specifically indicated that it would present closure related activities as recoverable under the Federal Mandate Statute. Petitioner's Exhibit No. 13-R, pp. 6-7. Mr. Swiz explained that Duke, IPL and NIPSCO did not ask for recovery of their pond closure costs in the proceedings Ms. Aguilar cited, and in fact the order in Cause No. 44765 specifically notes that Duke anticipates presenting closure related activities of existing surface impoundments and their associated costs in a future proceeding. Petitioner's Exhibit No. 13-R, p. 6, citing *Duke Energy Indiana*, Cause No. 44765, at *7 (IURC May 24, 2017). Each of the cases Ms. Aguilar cited were settled cases containing non-precedential language. Nevertheless, Mr. Swiz pointed out that the NIPSCO Order in Cause No. 44872, suggests that the OUCC agreed that closure costs can be recovered as federally mandated costs. Petitioner's Exhibit No. 13-R, p. 7.

Third, the OUCC contends that Vectren South should have presented alternative suitable locations to the West Pond for consideration. However, Ms. Retherford testified that the location was chosen because there was limited space at the Culley generating station. In other words, there was not an alternate location to explore. The statutory requirement to consider options does not require a utility to present alternatives that are not practical or feasible. Accordingly, we find the Culley 3 Compliance Projects are all federally mandated requirements and that Vectren South described them in its application.

(2) Energy utilities seeking recovery of Federally Mandated Costs must establish that the costs are incurred in connection with a compliance project, including capital, operating, maintenance, depreciation, tax or financing costs and describe the costs to be recovered. Ind. Code §§ 8-1-8.4-4 and -6(b)(1)(B). We have already found that the Culley 3 Compliance Projects constitute projects required by federally mandated requirements. Consequently, the costs associated with these projects constitute Federally Mandated Costs. These costs will consist of capital, operating, maintenance, depreciation, tax and financing costs. Vectren South identified the estimated costs to be recovered as Federally Mandated Costs. Costs associated with the dry handling bottom ash handling system and spray dryer evaporator system were identified by Vectren South witness Fischer. Petitioner's Exhibit No. 6, pp. 16-18, 26-28. Costs associated with the construction of a new lined process water and storm water retention pond were identified in Ms. Retherford's testimony. Petitioner's Exhibit No. 9, Attachment AMR-1. No party disputed the cost estimates for the Culley 3 Compliance Projects. Based on the evidence presented, we find that Vectren South has identified

federally mandated costs and reasonably described those costs. Those total costs are $95 million, and they are hereby approved. Petitioner's Exhibit No. 4, p. 26.

(3) Compliance with Federally Mandated Requirements (Ind. Code §§ 8-1-8.4-6(b)(1)(C)) and 8-1-8.4-7(b)(3)). No party disputed that the Culley 3 Compliance Projects will allow Vectren South to comply with ELG and CCR or that ELG and CCR are federally mandated. We previously addressed the OUCC's objections related to appropriateness of recovery. We have already found that the ELGs and CCR Rule are federally mandated requirements within the meaning of Ind. Code §§ 8-1-8.4-5 and 8-1-8.4-6(b)(1)(A) and 8-1-8.4-7(b)(3). Based on the evidence presented, we find that Vectren South's Culley 3 Compliance Projects, will allow the utility to comply with the ELGs and the CCR Rule. Therefore, we find that Vectren South has satisfied the requirements of Ind. Code § 8-1-8.4-6(b)(1)(C).

(4) Alternative Plans for Compliance (Ind. Code §§ 8-1-8.4-6(b)(1)(D) and 8-1-8.4-7(b)(3)). Ind. Code § 8-1-8.4-6(b)(1)(D) requires the Commission to examine "[a]lternative plan that demonstrate that the proposed compliance project is reasonable and necessary." Vectren South witness Diane Fischer testified about Black & Veatch's evaluation of the ELG Compliance Program for Culley to identify potential FGD discharge water treatment alternatives and ash transport water alternatives that could be implemented to comply with the ELGs. She sponsored two written reports setting forth Black & Veatch's analyses of the alternatives. Ms. Fischer testified that each of the potential discharge treatment technology alternatives assessed by Black & Veatch were screened for design concept feasibility, capital expense and operating expense.

With respect to FGD discharge water treatment, two main treatment alternatives were considered: (1) FGD treatment and discharge; and (2) zero liquid discharge ("ZLD"). Three technology types were evaluated within these two treatment alternatives: (1) for FGD treatment and discharge, physical/chemical pretreatment with biological treatment technology, (2) for ZLD, spray dryer evaporator technology, and (3) also for ZLD, brine concentrator/crystallizer technology. Ms. Fischer testified that multiple vendors providing such technologies were evaluated. A sensitivity analysis was then performed for each technology and vendor. Ms. Fischer's Discharge Treatment Report also included a cost assessment of all alternatives considered. Petitioner's Exhibit No. 10, p. 7. Ms. Fischer testified that Black & Veatch provided Vectren South with a final overall assessment of each technology and vendor offering based on Black & Veatch's analysis and the following attributes: (1) start-up/ramp up reliability; (2) technology readiness risk; (3) adaptability to sensitivity analysis scenarios; (4) operation and control risk; (5) heat rate impact risk; (6) number of operators; (7) capital and annual O&M costs; (8) susceptibility to future environmental regulations; (9) overall financial stability and credit rating. Black & Veatch ultimately recommended that Vectren move forward to a detailed engineering phase with Stochastic Differential Equation ("SDE") type technology if the maximum FGD wastewater flow rate of between 50 and 80 gpm is achieved through future testing and operations. Ms. Fischer explained the SDE solution ranks the highest among all technologies based on the attributes discussed above and the solution is economically viable and provides a zero discharge solution if the minimum FGD wastewater flow rate of between 50 and 80 gpm is achieved. The conceptual design evaluation indicated the SDE can be feasibly located and tied into the existing equipment at Culley. In addition, Ms. Fischer stated the ZLD solution provides certainty that any future change in EPA regulations would not apply at Culley since there would be no discharge of FGD wastewater.

With respect to ash transport, Ms. Fischer described Black & Veatch's analysis to identify alternative ash transport solutions that could be implemented at Culley to comply with ELG requirements, focused specifically on identifying options for removal and dewatering of bottom ash from the Culley Unit 3 boiler with truck transport and disposal of the dry material at an off-site location. Black & Veatch evaluated two categories of technologies: (1) dry conversion of the bottom ash system and (2) closed loop wet sluicing system. For dry conversion system, Black & Veatch evaluated a submerged chain conveyor under the existing bottom ash hopper. For the closed loop wet sluicing system, Black & Veatch evaluated both a dewatering bunker and a remote submerged chain conveyor. In comparing all technologies, Black & Veatch used the following quality attributes to select the preferred treatment: technical feasibility; total installed cost, O&M cost, estimated additional manpower ("FTE"), estimated footprint, major equipment, advantage, disadvantages and reliability. Ms. Fischer's testimony discussed in detail the advantages and disadvantage of each alternative. Black & Veatch prepared cost estimates for all technologies considered for addressing ash transport water. Black & Veatch ultimately recommended the submerged chain conveyor for Culley 3 compliance with ELG requirements, due to the complexity of design and comparatively higher installed cost of the other alternatives.

The only evidence offered in opposition as being an alternative plan was the OUCC's conclusory statement about possible alternative locations for the new lined pond. As we have previously found, the chosen site was selected because there are no alternative locations.

While the Commission gives significant weight to cost-effective planning and decision making when considering alternatives, the Federal Mandate Statute does not require that a utility demonstrate that the chosen compliance plan is the least cost option. Consistent with the Commission's finding in Indianapolis Power and Light's recent proceeding, Cause No. 44794 (IURC 4/26/2017), p. 30, 2017 Ind. PUC LEXIS 114, *92, (finding "it is important that the Petersburg Station is able to continue to operate on coal and protect customers from potential price volatility in the gas markets"), a reasonable alternative can be, and often is, a solution that includes risk balancing through a diversified portfolio.

Based on the evidence presented, we find that Vectren South considered alternative plans for compliance with the ELGs and the CCR Rule. The evidence shows that the Culley 3 Compliance Projects are reasonable and necessary.

(5) Useful Life of the Facility (Ind. Code §§ 8-1-8.4-6(b)(1)(E) and 8-1-8.4-7(b)(3)). Mr. Games testified that the investments in the Culley 3 Compliance Projects will allow for the continued operation of Vectren South's most efficient coal fired unit. Ms. Retherford described the environmental regulations requiring the Culley 3 Compliance Projects in order for Culley Unit 3 to continue operating. Ms. Retherford explained how closure of the Culley West pond will extend the useful life of Culley 3, because closure of the Culley West pond is necessary to provide a suitable location to construct a new pond that can continue to take non-CCR process water discharged from Culley Unit 3 and plant stormwater (i.e. surface water) which flows into the West Pond. Without this new lined process and stormwater pond, continued operation consistent with applicable regulations would be impossible after the Culley East pond commences closure.

No party disputes that issuance of a CPCN for the Culley 3 Compliance Projects will extend the useful life of Vectren South's Culley 3 unit or that Culley 3 would be required to retire in the near future if the Culley 3 Compliance Projects are not completed.

Based on the evidence presented, we find that Vectren South has satisfied the requirements of Ind. Code § 8-1-8.4-6(b)(1)(E).

(6) Conclusion. We find that the Culley 3 Compliance Projects will allow Vectren South to comply directly or indirectly with one or more federally mandated requirements and that public convenience and necessity will be served by the Culley 3 Compliance Projects.

ii. Accounting and Ratemaking Issues Associated with Culley Compliance Projects. Ind. Code § 8-1-8.4-7(c) states:

> If the commission approves under subsection (b) a proposed compliance project and the projected federally mandated costs associated with the proposed compliance project, the following apply:
> (1) Eighty percent (80%) of the approved federally mandated costs shall be recovered by the energy utility through a periodic retail rate adjustment mechanism that allows the timely recovery of the approved federally mandated costs. The Commission shall adjust the energy utility's authorized net operating income to reflect any approved earnings for purposes of IC 8-1-2-42(d)(3)and IC 8-1-2-42(g)(3).
> (2) Twenty percent (20%) of the approved federally mandated costs, including depreciation, allowance for funds used during construction, and post in service carrying costs, based on the overall cost of capital most recently approved by the commission, shall be deferred and recovered by the energy utility as part of the next general rate case filed by the energy utility with the commission.
> (3) Actual costs that exceed the projected federally mandated costs of the approved compliance project by more than twenty-five percent (25%) shall require specific justification by the energy utility and specific approval by the commission before being authorized in the next general rate case filed by the energy utility with the commission.

(1) Accounting and Ratemaking Treatment for ECA. Vectren South requests authority to implement a new annual rate adjustment mechanism ("ECA") pursuant to Ind. Code § 8-1-8.4-7 for the timely and periodic recovery of 80% of the federally mandated costs. Vectren South also requests approval of proposed changes to its electric service tariff relating to the proposed ECA mechanism, including the proposed Appendix E. Ind. Code §8-1-8.4-8 provides that an energy utility may, in a timely manner, recover 80% of all federally mandated costs through a periodic rate adjustment mechanism. Ind. Code §§ 8-1-8.4-4 and 8-1-8.4-7 provide that such costs include capital, AFUDC, O&M, depreciation, tax, and financing costs.

Vectren South witness Swiz described how the eligible costs associated with the Culley 3 Compliance Projects will be incorporated into the proposed ECA mechanism. He testified Vectren South will prepare in each annual filing a revenue requirement calculation accumulating all eligible costs incurred through December 31 of the previous calendar year. To provide for timely recovery, Mr. Swiz testified the proposed ECA will project an annualized level of expense related to the approved projects for the 12-month effective period. Mr. Swiz stated the annual revenue requirements will capture eligible new capital investments (both in service and Construction Work in Progress) related to the Culley 3 Compliance Projects, multiplied by the applicable rate of return, with depreciation, O&M and property tax expenses associated with the projects, and recovery of the regulatory assets recorded through interim deferral of depreciation expense, plan development expense, and PISCC, added to the resulting total. The revenue requirement for those projects will be the basis for the recovery of 80% of the eligible revenue requirement amounts in each annual ECA filing.

Mr. Swiz also described Vectren South's proposal to defer and subsequently recover depreciation expense as well as costs associated with development of the Culley 3 Compliance Projects through the ECA. The cumulative deferred balances of the regulatory assets recorded through interim deferral of such depreciation expenses would be amortized over the remaining life of the assets (20 years) and the amortization amount would be included in the ECA revenue requirements. Mr. Swiz stated the costs of development of the projects would be included for recovery within the ECA, with the balance amortized over a period of three years.

Vectren South proposes the pre-tax return on the new capital investment will be calculated by multiplying the pre-tax rate of return, based on the weighted average cost of capital ("WACC"), by total new capital investment related to the approved projects. Mr. Swiz testified Vectren South proposes to use a WACC in the ECA based upon the most recent approved WACC within Vectren South's TDSIC mechanism under Cause No. 44910, which is based on a return on equity ("ROE") of 10.4% as approved in Cause Nos. 43111 and 43839, Vectren South's two most recent base rate cases. Mr. Swiz stated the equity component of the rate used in the ECA revenue requirement calculation will be grossed up for recovery of income taxes, both state and federal, at then current rates.

Mr. Swiz testified that approved recoveries within each ECA filing will be calculated by taking the billing determinants by month multiplied by the applicable rates and charges for the ECA period. Any under recoveries resulting from instances in which ECA rates and charges are not in place for a full month will be recovered as an under-recovery variance in a subsequent ECA proceeding. Vectren South proposes to allocate ECA costs pursuant to the four-coincident peak allocation percentages for Vectren South utilized in its Cause No. 43406 RCRA15 and 43405 DSMA15 rate mechanisms.

With respect to the treatment of operating income, Mr. Swiz testified Vectren South will adjust its statutory earnings test under Ind. Code § 8-1-2-42(d)(3) to include the incremental earnings from approved ECA filings.

Mr. Swiz testified Vectren South proposes to file its ECA petitions and cases in chief annually, on May 1 of each year, with new ECA rates and charges becoming effective August 1 of each year. Each filing will be based on capital investments and expenses through the twelve months ended December of the prior calendar year. Variances will be reconciled in each ECA filing and recovered over the subsequent 12 month rate effective period. Vectren South seeks approval of its proposed Sheet No. 69, Appendix E, Environmental Cost Adjustment. Additional changes to Vectren South's rate schedules in its tariff are needed to reflect that the ECA will be applied monthly.

Industrial Group witness Gorman recommended that the ELG costs associated with the Culley 3 Compliance Projects be recovered within a base rate proceeding and not through the proposed ECA. He cited Vectren South's overall rate of return and stated Vectren South's costs have declined since the last base rate case. He also suggested that Vectren South should be permitted to recover a return on investment of no more than 9.8%.

Mr. Swiz explained on rebuttal that under the statutory test under Ind. Code § 8-1-2-42(d) and -42.3, performed in Vectren South's most recent FAC proceedings as of the time his rebuttal testimony was filed (Cause No. 38708 FAC 120), Vectren South's comprehensive earnings compared to authorized levels, including both changes in expenses and revenues, show that Vectren South is currently under-earning by approximately $6.5 million of net operating income and has been under-earning since February 2017. Mr. Swiz explained that depreciation and operating expense are driving much of these results, and Mr. Gorman does not capture those expenses in his calculation.

Eligibility for recovery through Ind. Code ch. 8-1-8.4 is not contingent on whether other costs have declined to offset the new federally mandated costs. Once we have made the required findings, 80% of the federally mandated costs "shall be recovered by the energy utility through a periodic retail rate adjustment mechanism." Ind. Code § 8-1-8.4-7(c)(1). In any event, we find that Mr. Swiz has adequately explained why Mr. Gorman's position is incorrect.

Mr. Swiz testified that pursuant to Ind. Code § 8-1-8.4-7, Vectren South seeks ratemaking treatment for 80% of the costs associated with the Culley 3 Compliance Projects through its proposed ECA mechanism. Specifically, Vectren South seeks timely recovery of all federally mandated costs associated with the Culley 3 Compliance Projects, including capital costs, AFUDC, post-in-service carrying cost charges ("PISCC"), O&M, depreciation expense, property tax expense, and other taxes, with 80% recovered through the ECA and the balance deferred for recovery in Vectren South's next rate case.

Vectren South proposes to implement construction work in progress ("CWIP") ratemaking treatment related to the recovery of financing costs incurred during construction of the Culley 3 Compliance Projects. In connection with CWIP ratemaking treatment, Vectren South will remove from the AFUDC-eligible balance the amount of investment included for recovery in the ECA, so that only the amount of the Culley 3 Compliance Projects investment not currently being recovered in the ECA would be eligible for AFUDC.

Mr. Swiz testified that Vectren South proposes to accrue post-in-service carrying charges on all eligible new capital investment from the date it is placed in service until the date it is included in rates. He explained the PISCC balances will be multiplied by the pre-tax rate of return within the ECA revenue requirement, at the WACC rate described herein. Unlike other utilities who have been granted such authority, Vectren South is not seeking to accrue and subsequently recover in the next base rate case PISCC on the 20% deferred balance discussed below.

OUCC witness Aguilar opposed Vectren South's request to recover pond closure costs for the Culley 3 Compliance Projects as part of the ECA because the OUCC's position is that Vectren South is already collecting pond closure costs within its depreciation rates. Ms. Aguilar also testified that neither Duke, IPL, nor NIPSCO are tracking pond closure costs. We have already addressed these positions and rejected them.

Based on the evidence presented, we find that the proposed ECA mechanism should allow for the timely and periodic recovery of 80% of Vectren South's approved federally mandated costs. We further find that Vectren South's request for approval to adjust its authorized net operating income to reflect an approved earnings associated with the Culley 3 Compliance Project for purposes of Ind. Code §§ 8-1-2-42(d)(3) and 8-1-2-42(g)(3) is consistent with Ind. Code § 8-1-8.4-7(c)(1).

Vectren South is authorized to defer (until captured within the ECA mechanism) and recover 80% of the approved federally mandated costs incurred in connection with the Culley 3 Compliance Projects through the approved ECA Mechanism pursuant to Ind. Code § 8-1-8.4-7, including capital, O&M, depreciation, taxes, financing, and carrying costs based on the current overall WACC and AFUDC. Vectren South is authorized to utilize CWIP ratemaking treatment for the Culley 3 Compliance Projects through the proposed ECA mechanism. Vectren South is authorized to defer post-in service costs of the Culley 3 Compliance Projects, including carrying costs based on the current overall WACC, depreciation, taxes and operating and maintenance expenses on an interim basis until such costs are recognized for ratemaking purposes through Vectren South's ECA mechanism or otherwise included for recovery in Vectren South's base rates in its next general rate case. Vectren South is authorized to defer and recover through the ECA mechanism 80% of its federally mandated costs, including but not limited to federally mandated costs incurred prior to and after approval of a final order in this proceeding to the extent that such costs are reasonable and consistent with the scope of the Culley 3 Compliance Projects described in Vectren South's evidence. Vectren South's proposed cost allocation factors are also approved.

(2) Accounting and Ratemaking Treatment for Deferred Costs. Indiana Code § 8-1-8.4-8 provides that 20% of the approved federally mandated costs, including depreciation, AFUDC, and PISCC, based on the overall cost of capital most recently approved by the Commission, shall be deferred and recovered by the energy utility as part of the next general rate case filed by the energy utility with the Commission. Vectren South proposes to defer as a regulatory asset 20% of all federally mandated costs incurred in connection with these projects.

Based on the evidence presented, the Commission finds Vectren South is authorized to defer 20% of the federally mandated costs incurred in connection with the Culley 3 Compliance Projects, and Vectren South may recover the deferred costs in its next general rate case as allowed by Ind. Code § 8-1-8.4-7(c)(2).

(3) Depreciation Treatment. Vectren South proposes to utilize a depreciation rate of 5%, representing a 20-year life on these investments. Mr. Swiz testified the proposed depreciation rate for the investments aligns with the estimated remaining life of Culley Unit 3.

No party opposed Vectren South's proposed depreciation rate for the investments required for the Culley 3 Compliance Projects.

Based on the evidence presented, we find that Vectren South's proposal to depreciate the individual projects included in the Culley 3 Compliance Projects based on a 5% depreciation rate is reasonable and is approved.

C. Recovery of Prior Pollution Control Investments. Our January 28, 2015 and June 22, 2016 Orders in Cause No. 44446 (the "44446 Orders") (1) granted Vectren South a CPCN for A.B. Brown Unit 1 and 2, Culley Unit 3 and Warrick Unit 3 clean coal technology projects and (2) authorized Vectren South to recover federally mandated costs associated with federally mandated requirements at A.B. Brown Units 1 and 2 (collectively the "MATS Projects"). Rather than recovering the costs of the MATS Projects through a tracking mechanism as authorized by Ind. Code § 8-1-8.4-7, Vectren South sought, and we granted, authority to defer these costs for recovery in a future proceeding. Vectren South now seeks to commence recovery of the MATS Projects' costs through the ECA pursuant to Ind. Code § 8-1-8.4-7.

Vectren South witness Swiz described the proposed recovery through the ECA in more detail. He indicated that Vectren South proposes recovery of the MATS Projects to begin on January 1, 2019 with the approval of ECA rates and charges recovering the specified revenue requirement. In accordance with applicable statutory requirements, Vectren South proposes to recover the 80% of eligible revenue requirements amounts for post-in-service carrying costs, incremental depreciation and property taxes and financing costs that Vectren South incurred to construct the MATS Projects and deferral of the remaining 20% of these costs for subsequent recovery in a base rate case. Vectren South will prepare an annual revenue requirement as part of the ECA to capture eligible capital investments in plant related to the MATS Projects, multiplied by the applicable rate of return, with depreciation, O&M, and property tax expenses associated with the MATS Projects added to the resulting total. To provide for timely recovery, Vectren South's proposed ECA will project an annualized level of expense related to these approved projects for the 12-month effective period.

Depreciation associated with the MATS Projects will be based on the currently approved depreciation rates applicable to the assets, as approved in Vectren South's last electric base rate case (Cause No. 43839). The pre-tax return on the new capital investment will be calculated by multiplying the pre-tax rate of return, based on the WACC, by total new capital investment related to the approved projects. Vectren South proposes to use a WACC in the ECA based upon the most recent approved WACC within Vectren South's TDSIC mechanism, Cause No. 44910. This WACC, approved by the Commission, represents an updated actual capital structure as of the cut-off date of each TDSIC filing, and includes the typical items captured in Vectren South's base rate case capital structure. This rate will be used in the ECA revenue requirement calculation, and the equity component will be grossed up for recovery of income taxes, both state and federal, at then current rates. O&M expense included for recovery in the ECA will reflect an annualized level of expense related to the MATS Projects. This O&M expense represents incremental chemical costs and other expenses associated only with the MATS Projects.

No party objected to Vectren South's proposal to commence recovery of the MATS Projects' costs, currently being deferred, through the ECA. We previously found the MATS Projects costs qualify as federally mandated costs in the 44446 Orders. While Vectren South proposed, and we approved of, deferral of these costs in lieu of the recovery through a periodic retail rate adjustment mechanism, Vectren South now seeks to recover the costs in accordance with Ind. Code § 8-1-8.4-7(c). We find that Vectren South shall be authorized to commence recovery of these MATS Projects' costs pursuant to Ind. Code § 8-1-8.4-7 through the ECA in accordance with the procedures outlined in Mr. Swiz's testimony.

6. **Confidentiality.** Vectren South filed motions for protection and nondisclosure of confidential and proprietary information on March 20, 2018, August 21, 2018, and September 10, 2018, respectively. In its motions, Vectren South states certain information redacted in the evidence is confidential, proprietary, competitively sensitive, and/or trade secrets. Docket entries were issued on March 29, August 27, and October 4, 2018 finding such information to be preliminarily confidential and protected from disclosure under Ind. Code §§ 8-1-2-29 and 5-14-3-4. The confidential information was subsequently submitted under seal. The Commission finds the

information for which Vectren South seeks confidential treatment is confidential trade secret information pursuant to Ind. Code § 8-1-2-29 and Ind. Code ch. 5-14-3, is exempt from public access and disclosure by Indiana law, and shall continue to be held by the Commission as confidential and protected from public access and disclosure.

IT IS THEREFORE ORDERED BY THE INDIANA UTILITY REGULATORY COMMISSION that:

1. Vectren South's request for a certificate of public convenience and necessity under Ind. Code ch. 8-1- 8.5 to construct an 850 MW CCGT and all associated relief requested is denied.

2. Vectren South's request for a certificate of public convenience and necessity for the Culley 3 Compliance Projects pursuant to Ind. Code ch. 8-1-8.4 and all associated relief requested is approved.

3. Vectren South's proposed recovery of federally mandated costs approved in connection with Cause No. 44446 through the ECA is approved as described in this Order.

4. Vectren South's proposed ECA, and Vectren South's proposed Sheet No. 69, Appendix E of its tariff to implement such ECA is approved.

5. The Confidential Information submitted under seal in this Cause pursuant to Vectren South's requests for confidential treatment is determined to be confidential trade secret information as defined in Ind. Code § 24-2-3-2 and shall continue to be held as confidential and exempt from public access and disclosure under Ind. Code §§ 8-1-2-29 and 5-14-3-4.

6. This Order shall be effective on and after the date of its approval.

HUSTON, KREVDA, OBER, AND ZIEGNER CONCUR; FREEMAN ABSENT:

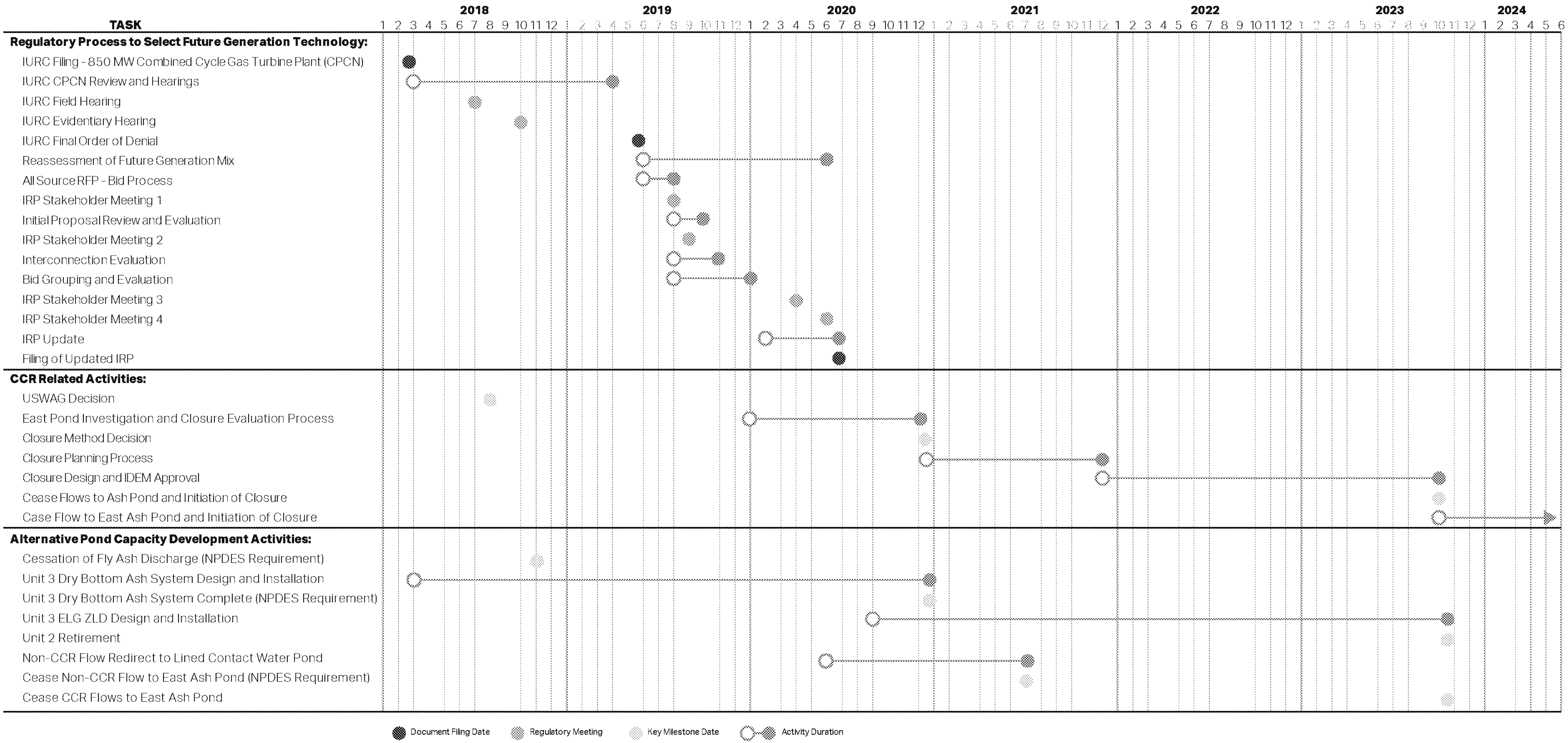
APPROVED: APR 24 2019

I hereby certify that the above is a true and correct copy of the Order as approved.

Mary M. Becerra

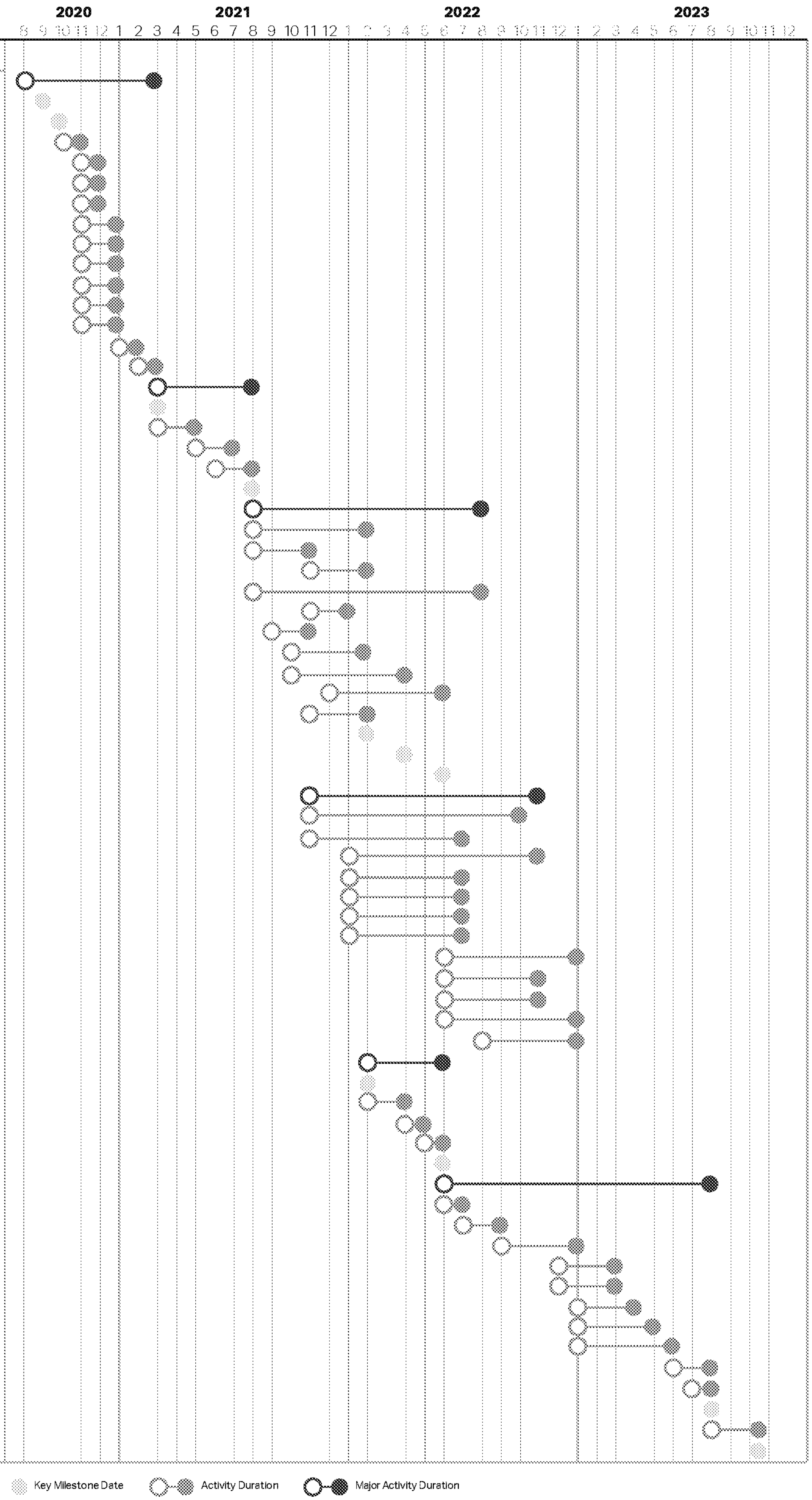
Mary M. Becerra
Secretary of the Commission

Appendix B
Schedule Activities and Milestone


TASK
2018
2019
2020
2021
2022
2023
2024
Regulatory Process to Select Future Generation Technology:
IURC Filing - 850 MW Combined Cycle Gas Turbine Plant (CPCN)
IURC CPCN Review and Hearings
IURC Field Hearing
IURC Evidentiary Hearing
IURC Final Order of Denial
Reassessment of Future Generation Mix
All Source RFP - Bid Process
IRP Stakeholder Meeting 1
Initial Proposal Review and Evaluation
IRP Stakeholder Meeting 2
Interconnection Evaluation
Bid Grouping and Evaluation
IRP Stakeholder Meeting 3
IRP Stakeholder Meeting 4
IRP Update
Filing of Updated IRP
CCR Related Activities:
USWAG Decision
East Pond Investigation and Closure Evaluation Process
Closure Method Decision
Closure Planning Process
Closure Design and IDEM Approval
Cease Flows to Ash Pond and Initiation of Closure
Case Flow to East Ash Pond and Initiation of Closure
Alternative Pond Capacity Development Activities:
Cessation of Fly Ash Discharge (NPDES Requirement)
Unit 3 Dry Bottom Ash System Design and Installation
Unit 3 Dry Bottom Ash System Complete (NPDES Requirement)
Unit 3 ELG ZLD Design and Installation
Unit 2 Retirement
Non-CCR Flow Redirect to Lined Contact Water Pond
Cease Non-CCR Flow to East Ash Pond (NPDES Requirement)
Cease CCR Flows to East Ash Pond
Document Filing Date
Regulatory Meeting
Key Milestone Date
Activity Duration

Appendix C
Detailed Schedule for Development of Alternative Capacity

TASK	DURATION
Project Definition and Specification Development	7
Engineering Services Contract Award	9/4/20
Project Kickoff	9/23/20
Information Request and Data Collection	1
Design Basis and Scope of Work	1
Geotechnical and Subsurface Investigation Specifications	1
Laser Scan and Topographic Survey Specifications	1
Preliminary Design and Schedule	2
Process Flow Diagrams and Material Balance	2
Site Arrangement and Conceptual General Arrangements	2
Electrical One-Lines and List	2
Constructability Review	2
Level 1 Project Schedule	2
Cost Estimate	1
Major Equipment Specifications	1
Vendor Selection	5
Issue Request for Proposal	MS
Contractor Bidding Period	2
Evaluation of Bids	2
Contract Negotiations	2
Award Contract	MS
Detailed Engineering and Design	12
Vendor Engineering	6
Initial Design Development	3
Final Design Development	3
Detailed Design	12
Vendor Document Review	2
Civil Design and Foundation Modifications	2
Structural Design New Ductwork	4
Mechanical Design	6
Electrical and Controls Design	6
Construction Specification	3
Construction Design Package- Civil & Structural	MS
Construction Design Package - Mechanical	MS
Construction Design Package- Electrical & Controls	MS
Equipment Fabrication and Delivery	12
Vendor Supplied Wastewater Spray Dryer System	11
Spray Dryer Vessel	8
Spray Machines /Nozzles and Ancillary Equipment	10
Pumps, Agitators, Control Valves, Instruments	6
Structural Support and Access Steel	6
Tanks & Piping	6
Enclosures	6
Balance of Plant	7
Ductwork	5
Structural Support and Access Steel	5
Electrical Power Supply - MCC, Transformers	7
Controls	5
Contractor Selection	4
Issue Request for Proposal	MS
Contractor Bidding Period	2
Evaluation of Bids	1
Contract Negotiations	1
Award Contract	MS
Construction and Start-up	14
Mobilization	1
Foundations	2
Structural and Access Steel	4
Spray Dryer Vessel	3
Ductwork	3
Equipment and Tanks	3
Piping	4
Electrical and Controls - Power Distribution, Controller, Cabling	5
Start-Up and Commissioning	2
Tie-Ins to Main Plant Ductwork (Dependent on Plant Outage Schedule)	1
Initial Operation	MS
Initial Operation Period	2
Cease Flow of CCR and Non-CCR Streams to Ash Pond	10/15/23



Appendix D
Certification of Compliance

Certification of Compliance

In accordance with 40 CFR §257.103(f)(1)(iv)(B)(1), I, _______________, being a qualified representative of Southern Industrial Gas & Electric Company, do hereby certify, to the best of my knowledge, information, and belief, that the F.B. Culley Station East Ash Pond is in compliance with all of the requirements of 40 CFR 257 Subpart D – Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments. F.B. Culley's CCR Compliance website is up-to-date and contains all the necessary documentation and notification postings.

____

Signed

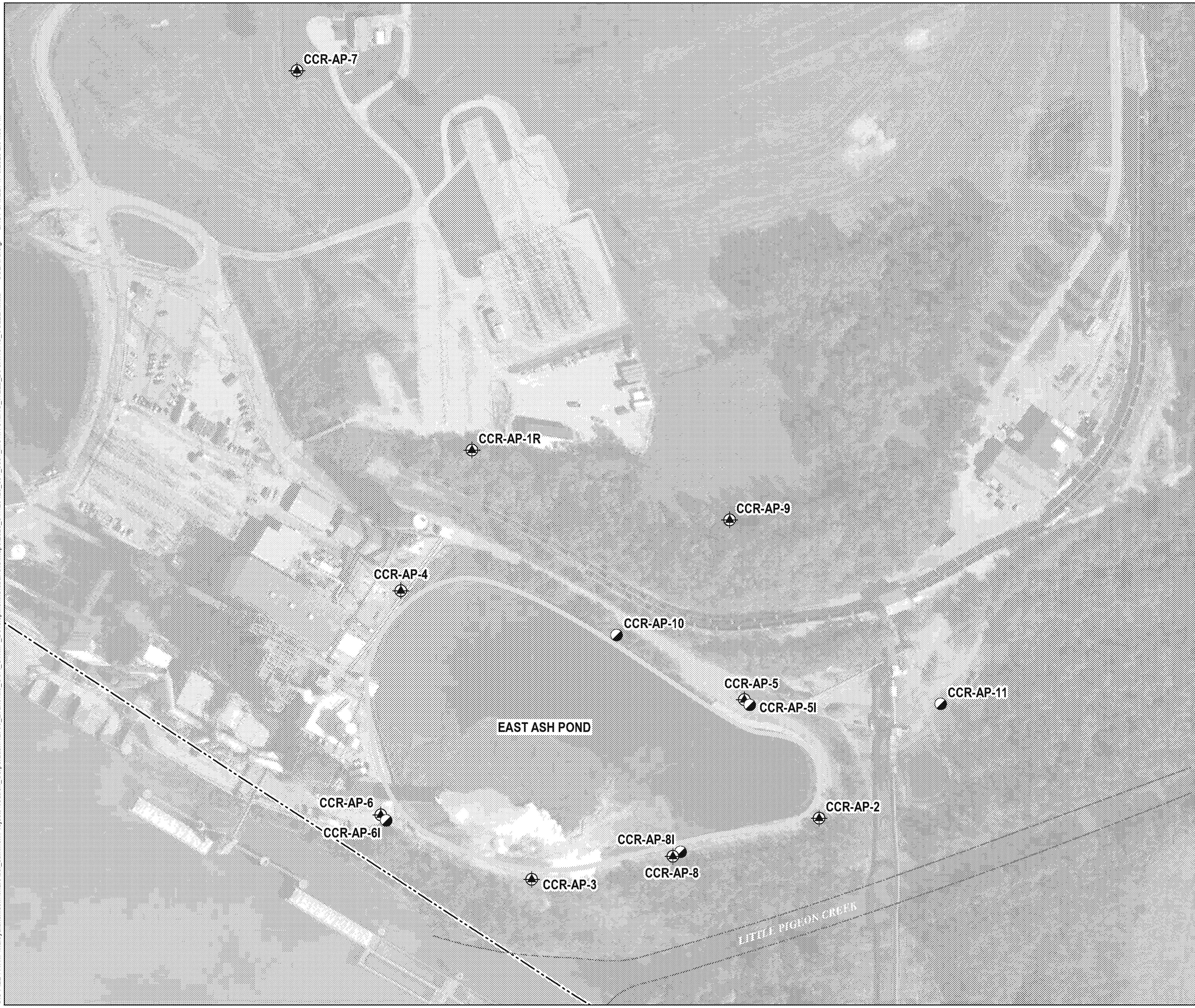
____

Printed Name

____

Date

Appendix E
Groundwater Monitoring Well Location



LEGEND

CCR-AP-11 MONITORING WELL

CCR-AP-6I NATURE AND EXTENT MONITORING WELL

APPROXIMATE UNIT BOUNDARY

APPROXIMATE PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS ARE APPROXIMATE
2. CCR COAL COMBUSTION RESIDUALS
3. AERIAL IMAGERY SOURCE: ESRI

N

0 220 440

SCALE IN FEET

HALEY ALDRICH

SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

GROUNDWATER MONITORING WELL LOCATIONS

JANUARY 2020

FIGURE 1

GIS FILE PATH: \\haleyaldrich.com\share\bol_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2020_01\129420_001_0001_MONITORING_WELL_LOCATIONS_CULLEY.mxd — USER: afeigl — LAST SAVED: 1/10/2020 2:01:30 PM

Appendix F
Well Construction Diagrams

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-1R

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	Stearns Drilling

File No.	42796-001
Sheet No.	1 of 3
Start	15 December 2015
Finish	08 March 2016
Driller	J. Gryska
H&A Rep.	J. Yonts
Elevation	438.5 (est.)
Datum	
Location	N 969,940 E 2,883,430

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	S	S	-	Rig Make & Model: Track
Inside Diameter (in.)	4.25	1 3/8	-	Bit Type: Drill Mud: None
Hammer Weight (lb)	-	140	-	Casing: Auger
Hammer Fall (in.)	-	30	-	Hoist/Hammer: Winch Automatic Hammer PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0	5 5 5 4	S1 16/24	0.0 2.0		438.0 0.5	--	Top soil with gravel parking lot base	-	-	-	-	-	-	-	-	-	-
						MH	Soft yellow-brown mottled tan elastic SILT, mps = 11 mm, no odor, moist -ALLUVIUM-	-	10	5	-	-	85	N	L	M	M
5	6 9 8 8	S2 18/24	4.0 6.0		434.5 4.0	ML	Medium stiff light brown SILT, mps = 3 mm, no odor, moist -ALLUVIUM-	-	-	-	-	10	90	R	L	N	L
10	2 4 6 5	S3 14/24	9.0 11.0		429.5 9.0	CL	Medium stiff yellow-brown lean CLAY, mps = 10 mm, no odor, moist -ALLUVIUM-	-	10	10	-	-	80	N	M	M	H
	4 6 50/4 -	S4 16/24	14.0 16.0			CL	Medium stiff light brown lean CLAY, mps = 5 mm, no odor, moist	-	-	-	-	10	90	N	M	M	H
15					423.5 15.0		Moderately hard slightly weathered light brown to yellow-brown to red fine-grained SANDSTONE, dry	-	-	-	-	-	-	-	-	-	-
	50/5 - - -	S5 5/5	18.0 21.0				Moderately hard moderately weathered yellow-brown to red fine-grained SANDSTONE, laminar bedding, dry	-	-	-	-	-	-	-	-	-	-
20							Medium hard, highly weathered, light brown SANDSTONE,	-	-	-	-	-	-	-	-	-	-

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/20/15	14:08				52.78

Sample ID
- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram
- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	15.0
Rock Cored (ft)	50
Samples	13S

Boring No. CCR-AP-1R

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

***Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.**

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-1R
File No. 42796-001
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20							extremely thin bedding, dry										
	50/2 - - -	S6 2/2	24.0 26.0		414.5 24.0		Medium hard highly weathered gray-brown SHALE, friable, dry	-	-	-	-	-	-	-	-	-	-
25																	
	50/5 - - -	S7 5/5	29.0 31.0				Similar as above	-	-	-	-	-	-	-	-	-	-
30							Similar as above	-	-	-	-	-	-	-	-	-	-
35	50/3 - - -	S8 3/3	35.0 37.0				Medium hard moderately weathered gray SHALE, friable, dry to moist	-	-	-	-	-	-	-	-	-	-
40	50/4 - - -	S9 4/4	40.0 42.0				Medium hard moderately weathered gray SHALE, friable, moist	-	-	-	-	-	-	-	-	-	-
45	50/3 - - -	S10 3/3	45.0 47.0				Similar as above	-	-	-	-	-	-	-	-	-	-

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-1R

HALEY ALDRICH — TEST BORING REPORT

Boring No. CCR-AP-1R
File No. 42796-001
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50	- - -	S11 5/5	50.0 55.0		388.5 50.0		Gray SANDSTONE composed of medium to fine sand. No apparent fractures.	-	-	-	-	-	-	-	-	-	-
					385.1 53.4		Black organic rich layers, coal possible, breaks along laminae with mica and plants (fossil).	-	-	-	-	-	-	-	-	-	-
							Gray SILTSTONE with trace SHALE laminae.	-	-	-	-	-	-	-	-	-	-
55	- - -	S12 5/5	55.0 60.0				Similar to above except 55.2 ft to 55.4 ft black and gray turbidite layer.	-	-	-	-	-	-	-	-	-	-
							Gray SHALE with layers of siltstone, plant (fossil) stems and mica breaks.	-	-	-	-	-	-	-	-	-	-
60	- - -	S13 5/5	60.0 65.0				Gray SILTSTONE with lamiae of SHALE but mostly SHALE.	-	-	-	-	-	-	-	-	-	-
								-	-	-	-	-	-	-	-	-	-
							Gray black SHALE with a few thin beds of gray (lighter) siltstone, pyrite rich SHALE layer from approximately 61.0 ft 61.3 ft.	-	-	-	-	-	-	-	-	-	-
							SHALE/SILTSTONE slight variation throughout except coarser silty layers.	-	-	-	-	-	-	-	-	-	-
65					373.5 65.0		BOTTOM OF EXPLORTION 65.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-1R

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-2

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	Stearns Drilling

File No. 42796-001
Sheet No. 1 of 2
Start 16 December 2015
Finish 16 December 2015
Driller J. Gryska
H&A Rep. E. Shirley
Elevation 394.4 (est.)
Datum
Location N 969,118 E 2,884,169

	Casing	Sampler	Barrel
Type	S	S	-
Inside Diameter (in.)	4.25	1 3/8	-
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures
Rig Make & Model: Track
Bit Type:
Drill Mud: None
Casing: Auger
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0	3 5 8 8	S1 21/24	0.0 2.0				6-inch gravel base	-	-	-	-	-	-	-	-	-	-
					393.9 0.5	ML	Medium stiff light brown SILT, mps = 1 mm, no odor, moist -FILL-	-	-	-	-	5	95	S	L	N	M
5	3 5 6 6	S2 16/24	3.5 5.5			ML	Similar to S1 above	-	-	-	-	5	95	S	L	N	M
10	0 2 3 4	S3 18/24	8.5 10.5			ML	Similar to S2 above except organic material observed and soft	-	-	-	-	5	95	S	L	N	M
15	0 2 3 6	S4 21/24	13.5 15.5		380.4 14.0	CL	Soft light brown lean CLAY, mps = 3 mm, no odor, moist -FILL-	-	-	-	-	5	95	N	M	M	H
20	1 3 3	S5 24/24	18.5 20.5			CL	Soft dark brown lean CLAY, no odor, moist, organic material observed and wood fibers approximately 19.5 feet	-	-	-	-	-	100	S	L	M	M

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/20/15	14:00				32.48

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 46.0
Rock Cored (ft) -
Samples 15S

Boring No. CCR-AP-2

Field Tests:
Dilatancy: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

*Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.
Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-2
File No. 42796-001
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	6						-FILL										
	2 3 6 7	S6 22/24	23.5 25.5			CL	Similar as above	-	-	-	-	-	100	S	L	M	M
25																	
						CL	Similar as above except organic wood fibers observed	-	-	-	-	-	100	S	L	M	M
	1 3 4 6	S7 25/24	28.0 30.0														
30	2 3 4 4	S8 23/24	30.0 32.0			CL	Similar as above	-	-	-	-	-	100	S	L	M	M
	1 3 4 5	S9 23/24	32.0 34.0				Similar as above	-	-	-	-	-	100	S	L	M	M
35	0 3 4 4	S10 21/24	34.0 36.0		359.4 35.0	MH	Soft, brown, elastic SILT, no odor, moist	-	-	-	-	-	100	S	M	M	M
							-ALLUVIUM-										
	1 3 5 6	S11 23/24	36.0 38.0			MH	Similar as above	-	-	-	-	-	100	S	M	M	M
	0 2 3 4	S12 22/24	38.0 40.0			MH	Similar as above	-	-	-	-	-	100	S	M	M	M
40	1 2 3 4	S13 24/24	40.0 42.0			MH	Similar as above	-	-	-	-	-	100	S	M	M	M
					352.9 41.5	ML	Soft brown sandy SILT, mps = 1 mm, no odor, wet	-	-	-	-	30	70	R	L	N	L
	1 2 2 2	S14 24/24	42.0 44.0		352.4 42.0	MH	Soft brown elastic SILT, no odor, wet	-	-	-	-	-	100	S	M	M	M
							1-inch sandy SILT at 43.5 feet	-	-	-	-	30	70	S	M	M	M
45	0 1 2 2	S15 24/24	44.0 46.0			MH	Similar as above except more sand	-	-	-	-	40	60	S	M	M	M
					348.4 46.0		-BOTTOM OF EXPLORATION 46.0 FT-										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-2

H&A-TEST BORING-07-1 HA-LIB09-REV.GLB HA-TB+CORE+WELL-07-1.GDT \\GRN\COMMON\42796 - VECTREN\FB CULLEY\GINT\F.B. CULLEY LOGS.GPJ Apr 20, 17

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-3

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	Stearns Drilling

File No.	42796-001
Sheet No.	1 of 2
Start	15 December 2015
Finish	15 December 2015
Driller	J. Gryska
H&A Rep.	E. Shirley
Elevation	395.1 (est.)
Datum	
Location	N 969,008 E 2,883,542

	Casing	Sampler	Barrel
Type	S	S	-
Inside Diameter (in.)	4.25	1 3/8	-
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Track
Bit Type:
Drill Mud: None
Casing: Auger
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0	12 24 24 16	S1 24/24	0.0 2.0				Gravel and sand road base material	-	-	-	-	-	-	-	-	-	-
					394.1 1.0	ML	Stiff dark brown SILT, mps = 20 mm, no odor, moist. Grades brown at 1.75 feet -FILL-	5	5	10	-	-	80	S	L	L	L
5	5 7 8 7	S2 17/24	4.0 6.0		390.1 5.0	CL	Stiff dark brown lean CLAY, mps = 10 mm, no odor, moist, organic material observed -FILL-	-	5	5	-	-	90	N	M	M	H
10	1 1 1 1	S3 16/24	9.0 11.0		385.1 10.0	MH	Soft brown elastic SILT, mps = 5 mm, no odor, moist -FILL-	-	-	-	-	15	85	S	L	L	M
15	1 1 2 4	S4 11/24	14.0 16.0		380.1 15.0	CL	Soft brown lean CLAY, mps = 12 mm, no odor, moist -FILL-	-	5	-	-	-	95	N	M	M	H
20	2 2	S5 19/24	19.0 21.0														

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/20/15	13:40				43.00

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	45.0
Rock Cored (ft)	-
Samples	15S

Boring No. CCR-AP-3

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

*Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-07-1 HA-LIB09-REV.GLB HA-TB+CORE+WELL-07-1.GDT \\GRN\COMMON\42796 - VECTREN\FB CULLEY\GINT\F.B. CULLEY LOGS.GPJ Apr 20, 17

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-3
File No. 42796-001
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	3 4					CL	Medium stiff brown lean CLAY, mps = 25 mm, no odor, moist	5	5	5	-	-	85	N	M	M	H
25	1 1 3 4	S6 18/24	24.0 26.0			CL	Soft dark brown lean CLAY, mps = 5 mm, no odor, moist	-	-	-	5	5	90	N	M	M	H
	0 0 1 3	S7 24/24	28.0 30.0			CL	Soft dark brown lean CLAY, mps = 3 mm, no odor, moist	-	-	-	-	5	95	N	M	M	H
30	0 2 3 5	S8 21/24	30.0 32.0			CL	Similar as above	-	-	-	-	5	95	N	M	M	H
	0 0 3 4	S9 24/24	32.0 34.0			CL	Similar as above	-	-	-	-	5	95	N	M	M	H
35	3 5 6 7	S10 20/24	34.0 36.0			CL	Similar as above except wood in shoe at 36 feet	-	-	-	-	5	95	N	M	M	H
	2 5 5 9	S11 22/24	36.0 38.0			CL	Similar as above	-	-	-	-	5	95	N	M	M	H
	3 5 6 6	S12 22/24	38.0 40.0			CL	Similar as above	-	-	-	-	5	95	N	M	M	H
40	2 3 4 5	S13 24/24	40.0 42.0		355.1 40.0	CL	Similar as above except organic material and interbedded 1- to 2-inch sand layers -ALLUVIUM-	-	-	-	-	5	95	N	M	M	H
	0 1 2 3	S14 24/24	42.0 44.0			CL	Similar as above	-	-	-	-	5	95	N	M	M	H
	0 0	S15 12/12	44.0 45.0		350.6 44.5	CL	Similar as above	-	-	-	-	5	95	N	M	M	H
						MH	Dark brown SILT, moist to wet at 44.5 feet	-	-	-	-	5	95	S	L	L	L
45	- -				350.1 45.0		-BOTTOM OF EXPLORATION 45 FT-										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-3

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-4

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	Stearns Drilling

File No.	42796-001
Sheet No.	1 of 2
Start	16 December 2015
Finish	16 December 2015
Driller	J. Gryska
H&A Rep.	E. Shirley
Elevation	395.4 (est.)
Datum	
Location	N 969,642 E 2,883,282

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	S	S	-	Rig Make & Model: Track
Inside Diameter (in.)	4.25	1 3/8	-	Bit Type: Drill Mud: None
Hammer Weight (lb)	-	140	-	Casing: Auger Hoist/Hammer: Winch Automatic Hammer
Hammer Fall (in.)	-	30	-	PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0	6 6 4 7	S1 19/24	0.0 2.0				Gravel base	-	-	-	-	-	-	-	-	-	-
					394.4 1.0	CL	Stiff brown lean CLAY, mps = 10 mm, no odor, moist -FILL-	5	-	-	-	-	95	N	M	M	H
5	4 6 10 12	S2 15/24	4.0 6.0		391.4 4.0	SW	Loose brown well-graded SAND, mps = 8 mm, no odor, moist -FILL-	-	5	25	35	30	5	-	-	-	-
10	1 2 1 2	S3 12/24	9.0 11.0			SW	Very loose brown well-graded SAND, mps = 9 mm, no odor, wet -FILL-	-	5	30	35	25	5	-	-	-	-
15	3 5 8 10	S4 10/24	14.0 16.0		381.4 14.0	MH	Medium stiff brown elastic SILT, no odor, moist -ALLUVIUM-	-	-	-	-	-	100	S	L	L	M
20	2 3	S5 15/24	19.0 21.0			MH	Soft, brown, elastic SILT, no odor, moist	-	-	-	-	-	100	S	L	L	M

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/20/15	13:33				7.11

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	35.5
Rock Cored (ft)	-
Samples	10S

Boring No. CCR-AP-4

Field Tests:
Dilatancy: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

*Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-4
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Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	4 5																
25	3 3 2 3	S6 19/24	24.0 26.0		371.4 24.0	CL	Soft dark brown lean CLAY, mps = 2 mm, no odor, moist -ALLUVIUM-	-	-	-	-	5	95	N	M	M	H
	1 2 4 3	S7 24/24	28.0 30.0			CL	Similar as above	-	-	-	-	-	-	-	-	-	-
30	0 3 2 3	S8 21/24	30.0 32.0			CL	Similar as above	-	-	-	-	-	-	-	-	-	-
							2-inch pocket of brown SILT at 31.5 feet	-	-	-	-	-	-	-	-	-	-
	1 2 4 7	S9 22/24	32.0 34.0			CL	Similar as above	-	-	-	-	-	-	-	-	-	-
						CL	Medium stiff gray mottled brown lean CLAY, mps = 12 mm, no odor, moist	-	5	5	5	-	85	N	M	M	H
35	2 4 50/1 -	S10 13/24	34.0 36.0		360.4 35.0		Highly weathered gray SHALE, friable	-	-	-	-	-	-	-	-	-	-
					359.9 35.5		-REFUSAL AT 35.5 FT-										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-4

H&A-TEST BORING-07-1 HA-LIB09-REV.GLB HA-TB+CORE+WELL-07-1.GDT \\GRN\COMMON\42796 - VECTREN\FB CULLEY\GINT\F.B. CULLEY LOGS.GPJ Apr 20, 17

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-5

Project: CCR Hydrogeologic Characterization, F.B. Culley Generating Station
Client: Southern Indiana Gas & Electric Company
Contractor: Stearns Drilling

File No. 42796-001
Sheet No. 1 of 2
Start: 18 December 2015
Finish: 18 December 2015
Driller: J. Gryska
H&A Rep.: E. Shirley
Elevation: 394.8 (est.)
Datum:
Location: N 969,380 E 2,884,017

	Casing	Sampler	Barrel
Type	S	S	-
Inside Diameter (in.)	4.25	1 3/8	-
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures
Rig Make & Model: Track
Bit Type:
Drill Mud: None
Casing: Auger
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0	5 5 7 9	S1 21/24	0.0 2.0		394.3 0.5		Gravel base	-	-	-	-	-	-	-	-	-	-
						CL	Medium stiff brown gravelly lean CLAY, mps = 33 mm, no odor, moist -FILL-	25	5	-	-	-	70	N	M	M	H
5	4 7 9 16	S2 24/24	4.0 6.0			CL	Medium stiff brown gravelly lean CLAY, mps = 25 mm, no odor, moist	25	15	-	-	-	65	N	M	M	H
10	2 4 3 2	S3 14/24	9.0 11.0		385.3 9.5	CL	Soft gray lean CLAY with weathered shale, mps = 40 mm, no odor, wet	40	-	-	-	-	60	N	M	M	H
							Moderately hard moderately weathered gray SHALE, friable, wet	-	-	-	-	-	-	-	-	-	-
15	4 2 3 3	S4 14/24	14.0 16.0				Medium hard highly weathered gray SHALE, friable, moist	-	-	-	-	-	-	-	-	-	-
20	8 19	S5 14/24	19.0 21.0				Medium hard highly weathered gray SHALE, friable, moist	-	-	-	-	-	-	-	-	-	-

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
12/20/15	14:04				9.92

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 9.5
Rock Cored (ft) 35.5
Samples 14S

Boring No. CCR-AP-5

Field Tests:
Dilatancy: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

*Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.
Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-5
File No. 42796-001
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Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	6 12																
25	5 6 7 9	S6 15/24	24.0 26.0				Medium hard highly weathered gray SHALE, friable, moist	-	-	-	-	-	-	-	-	-	-
					369.3 25.5		Moderately hard highly weathered brown SANDSTONE, friable, moist	-	-	-	-	-	-	-	-	-	-
	4 3 6 8	S7 20/24	28.0 30.0				Similar as above except moderately weathered at 28 feet	-	-	-	-	-	-	-	-	-	-
							Similar as above except highly weathered and brown to gray at 29 feet	-	-	-	-	-	-	-	-	-	-
30	2 4 4 4	S8 17/24	30.0 32.0														
	1 3 4 5	S9 16/24	32.0 34.0				Similar as above	-	-	-	-	-	-	-	-	-	-
35	3 2 2 2	S10 19/24	34.0 36.0				Similar as above	-	-	-	-	-	-	-	-	-	-
							Soft highly weathered brown SANDSTONE, wet	-	-	-	-	-	-	-	-	-	-
	2 3 4 19	S11 20/24	36.0 38.0				Medium hard highly weathered brown SANDSTONE, friable, moist	-	-	-	-	-	-	-	-	-	-
	36 13 6 6	S12 14/24	38.0 40.0				Similar as above	-	-	-	-	-	-	-	-	-	-
40	9 33 22 16	S13 21/24	40.0 42.0				Similar as above	-	-	-	-	-	-	-	-	-	-
	6 20 38 40	S14 14/24	42.0 44.0				Similar as above	-	-	-	-	-	-	-	-	-	-
					351.3 43.5		Soft, black COAL, friable, moist	-	-	-	-	-	-	-	-	-	-
					350.8 44.0		BOTTOM OF EXPLORTION 44.0 FT-										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-5

HALEY ALDRICH TEST BORING REPORT

Boring No. CCR-AP-6

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	Stearns Drilling

File No.	42796-001
Sheet No.	1 of 2
Start	08 March 2016
Finish	09 March 2016
Driller	J. Gryska
H&A Rep.	S. Lewis
Elevation	397.0 (est.)
Datum	
Location	N 969,122 E 2,883,285

	Casing	Sampler	Barrel
Type	-	S	-
Inside Diameter (in.)	-	1 3/8	-
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures
Rig Make & Model: CME 850 XR Air Track
Bit Type:
Drill Mud: None
Casing: Auger
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0						ML	Brown/dark brown SILT -FILL-	-	-	-	-	-	-	-	-	-	-
	2 7 10 7	S1 18/24	3.5 5.5			ML	Very stiff bown SILT (ML), mps 19.0 mm, no odor, dry	-	5	-	-	10	85	-	-	-	-
5																	
	3 8 9 12	S2 20/24	8.5 10.5			ML	Very stiff olive brown SILT (ML), mps 2.0 mm, no odor, dry, wood fragments present	-	-	-	5	5	90	-	-	-	-
10																	
	2 3 3 4	S3 18/24	13.5 15.5		383.5 13.5	CL	Medium stiff olive gray lean CLAY with sand (CL), mps 2.0 mm, no odor, moist, rounded sand, black wood fragments present -FILL-	-	-	-	15	5	80	-	-	-	-
15																	
	1 1 3	S4 22/24	18.5 20.5			CL	Soft olive gray lean CLAY with sand (CL), mps 2.0 mm, no odor, wet, black wood fragments present, rounded sand	-	-	-	10	5	85	-	-	-	-
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	45.5
Rock Cored (ft)	-
Samples	15S

Boring No. CCR-AP-6

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

*Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-6
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Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	6																
25	2 2 4 4	S5 22/24	23.5 25.5			CL	Medium stiff olive gray lean CLAY with sand (CL), mps 2.0 mm, no odor, moist, black wood fragments present, rounded sand	-	-	-	10	5	85	-	-	-	-
	4 5 6 6	S6 18/24	28.5 30.5		368.5 28.5	SW-SC	Medium dense olive gray well graded SAND with clay and gravel (SW-SC), mps 19.0 mm, no odor, wet	15	15	20	20	10	20	-	-	-	-
30					367.5 29.5	SC	Medium dense olive gray clayey SAND (SC), no odor, wet, wood fragments present -ALLUVIUM-	-	-	-	10	60	30	-	-	-	-
	3 4 7 8	S7 12/24	33.5 35.5				*Drove with 3.0 in. spoon due to no recovery.	-	-	-	-	-	-	-	-	-	-
35					363.0 34.0	CL	Stiff olive gray lean CLAY with sand (CL), mps 2.0 mm, no odor, wet, wood fragments present -ALLUVIUM-	-	-	-	15	5	80	-	-	-	-
40	2 2 2 3	S8 24/24	38.5 40.5			CL	Soft gray lean CLAY (CL), no odor, wet, wood fragments present	-	-	-	5	5	90	-	-	-	-
45	1 3 2 3	S9 24/24	43.5 45.5			CL	Medium stiff gray sandy lean CLAY (CL), no odor, wet, wood fragments present	-	-	-		40	60	-	-	-	-
					351.5 45.5		BOTTOM OF EXPLORATION 45.5 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-6

HALEY ALDRICH TEST BORING REPORT

Boring No. CCR-AP-7

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	Stearns Drilling

File No.	42796-001
Sheet No.	1 of 2
Start	09 March 2016
Finish	09 March 2016
Driller	J. Gryska
H&A Rep.	S. Lewis
Elevation	429.5 (est.)
Datum	
Location	N 970,775 E 2,883,090

	Casing	Sampler	Barrel
Type	-	S	-
Inside Diameter (in.)	-	1 3/8	-
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures
Rig Make & Model: CME 850 XR Air Track
Bit Type:
Drill Mud: None
Casing: Auger
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0						ML	Brown SILT (ML), trace coarse gravel -FILL-	-	-	-	-	-	-	-	-	-	-
	1 1 2 3	S1 16/24	3.0 5.0			ML	Soft brown SILT with sand (ML), no odor, moist, mottle with gray and red colors	-	-	-	-	15	85	-	-	-	-
5																	
	2 2 2 7	S2 17/24	8.0 10.0		421.5 8.0	ML	Very stiff olive brown SILT (ML), mps 2.0 mm, no odor, dry, wood fragments present -ALLUVIUM-	-	-	-	-	15	85	-	-	-	-
10																	
	1 2 3 2	S3 19/24	13.0 15.0			ML	Medium stiff gray SILT with sand (CL), no odor, moist, wood fragments present	-	-	-	-	15	85	-	-	-	-
15																	
	1 2 3 3	S4 20/24	18.0 20.0			ML	Medium stiff gray SILT with sand (ML), no odor, wet	-	-	-	-	15	85	-	-	-	-
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	35.0
Rock Cored (ft)	-
Samples	5S

Boring No. CCR-AP-7

Field Tests: Dilatancy: R - Rapid S - Slow N - None. Toughness: L - Low M - Medium H - High. Plasticity: N - Nonplastic L - Low M - Medium H - High. Dry Strength: N - None L - Low M - Medium H - High V - Very High

*Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-7
File No. 42796-001
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20																	
	1 1 2 1	S5 24/24	23.0 25.0			ML	Soft gray sandy SILT (ML), no odor, wet	-	-	-	-	30	70	-	-	-	-
25																	
	1 1 1 2	S6 24/24	28.0 30.0			CL	Soft gray lean CLAY (CL), no odor, wet, mottled with black colors, possibly organic matter	-	-	-	-	10	90	-	-	-	-
30																	
	1 2 3 3	S7 24/24	33.0 35.0			CL	Medium stiff gray lean CLAY (CL), no odor, wet	-	-	-	-	10	90	-	-	-	-
35					394.5 35.0		BOTTOM OF EXPLORATION 35.5 FT Notes: Well set at 30.0 ft. 35.0 ft o 34.0 ft backfilled with bedtonite. 30.0 ft to 34.0 ft backfilled with sand.										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-7

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-8

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	Stearns Drilling
File No.	42796-001
Sheet No.	1 of 2
Start	15 February 2017
Finish	15 February 2017
Driller	W. Bates
H&A Rep.	S.Lewis
Elevation	394.1 (est.)
Datum	
Location	N 969,046 E 2,883,847

	Casing	Sampler	Barrel
Type	S	S	--
Inside Diameter (in.)	4.25	1 3/8	--
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Track
Bit Type:
Drill Mud: None
Casing: Auger
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0																	
	6 7 9 10	S1 18	3.5 5.5			ML	Very stiff, brown, SILT(ML), MPS = 19 mm, no structure, no odor, dry	-	10	-	-	5	85	-	-	L	-
5					389.6 4.5	ML	-FILL- Very stiff, brown, SILT(ML), MPS = 4 mm, no structure, no odor, dry -FILL-	-	-	-	-	5	95	-	-	L	-
	3 2 3 4	S2 16	8.5 10.5		385.6 8.5	CL	Stiff, grayish brown, lean CLAY (CL), MPS = < 0.08 mm, no structure, no odor, dry, rootlets present	-	-	-	-	-	100	-	-	M-H	-
10																	
	3 2 3 4	S3 20	13.5 15.5		380.6 13.5	CL	Medium stiff, gray, lean CLAY (CL), MPS = < 0.08mm, no structure, no odor, moist	-	-	-	-	-	100	-	-	M-H	-
15																	
	3 3 4	S4 18	18.5 20.5		375.6 18.5	CL	Medium stiff, dark gray, lean CLAY (CL), MPS = < 0.08mm, no structure, no odor, moist, black wood fragments present	-	-	-	-	-	100	-	-	M-H	-
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
2/16/17	16:00				Dry

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	45.5
Rock Cored (ft)	-
Samples	9S

Boring No. CCR-AP-8

Field Tests:
Dilatancy: R - Rapid S - Slow N - None
Toughness: L - Low M - Medium H - High
Plasticity: N - Nonplastic L - Low M - Medium H - High
Dry Strength: N - None L - Low M - Medium H - High V - Very High

*Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.
Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-8
File No. 42796-001
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	5																
	2 2 3 4	S5 20	23.5 25.5		370.6 23.5	CL	Similar to S4, rootlets present	-	-	-	-	-	100	-	-	M-H	-
25																	
	1 2 3 3	S6 23	28.5 30.5		365.6 28.5	CL	Similar to S4	-	-	-	-	-	100	-	-	M-H	-
30																	
	2 2 3 5	S7 24	33.5 35.5		360.6 33.5	CL	Simlar to S4	-	-	-	-	-	100	-	-	M-H	-
35																	
					358.1 36.0	CL	Medium Stiff, dark gray, sandy lean CLAY (CL), MPS = 0.43 mm, interbedded, no odor, wet -ALLUVIUM-	-	-	-	-	30	70	-	-	M	-
					357.9 36.3	CL	Medium stiff, gray, lean CLAY (CL), MPS = < 0.08mm, no structure, no odor, moist, black wood fragments present -ALLUVIUM-	-	-	-	-	-	100	-	-	M-H	-
	2 2 4 6	S8 24	38.5 40.5		355.6 38.5	CL	Similar to S7	-	-	-	-	-	100	-	-	M-H	-
40																	
	1 2 4 4	S9 24	43.5 45.5														
45					348.9 45.3	CL	Medium Stiff, gray, sandy lean CLAY (CL), MPS = 0.43, interbedded, no odor, wet	-	-	-	-	30	70	-	-	M	-
					348.6 45.5		END OF BORING AT 45.5 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-8

HALEY ALDRICH — TEST BORING REPORT

Boring No. CRR-AP-9

Project	CCR Hydrogeologic Characterization, F.B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	Stearns Drilling

File No.	42796-001
Sheet No.	1 of 3
Start	14 February 2017
Finish	15 February 2017
Driller	W.Bates
H&A Rep.	S.Lewis
Elevation	445.6 (est.)
Datum	
Location	N 969,769 E 2,883,999

	Casing	Sampler	Barrel
Type	S	S	--
Inside Diameter (in.)	4.25	1 3/8	--
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Track
Bit Type:
Drill Mud: None
Casing: Auger/Steel
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model:

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0																	
	5 6 7 8	S1 17	3.5 5.5			ML	Stiff, brownish gray, SILT (ML), MPS = 0.08, laminated with interbedded layers of clay, no odor, dry	-	-	-	-	-	100	-	-	L-M	-
5							-ALLUVIUM-										
	4 7 9 11	S2 21	8.5 10.5		437.1 8.5	CL	Very stiff, grayish brown CLAY (CL), MPS = 0.08, laminated with interbedded layers of silt, no odor, dry, orange and black mottling	-	-	-	-	-	100	-	-	M	-
10																	
	5 8 20 50/2	S3 15	13.5 15.5		431.1 14.5		Gray, soft weathered SHALE, no structure, clayey, brown mottling, dry	-	-	-	-	-	-	-	-	-	-
15	- - - -	S4 53	15.1 20.1		430.5 15.1		Switched to rock coring at 15.5 ft	-	-	-	-	-	-	-	-	-	-
							Gray, LIMESTONE, no structure, fracture at 16.5 feet										
20																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	14.5
Rock Cored (ft)	55.3
Samples	14S

Boring No. CRR-AP-9

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

*Note: Maximum particle size (mps) is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. CRR-AP-9
File No. 42796-001
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
20	- - - -	S5 60	19.8 24.8		425.6 20.0		Gray, weathered SHALE, no structure, organic fragments 20.5-21.0 feet	-	-	-	-	-	-	-	-	-	-
					421.1 24.5		Light gray, weathered SHALE, no structure	-	-	-	-	-	-	-	-	-	-
25	- - - -	S6 58	24.8 29.8		420.6 25.0		Gray, fine grained SANDSTONE	-	-	-	-	-	-	-	-	-	-
					416.6 29.0		Gray, fine grained SANDSTONE, interbedded layers of soft weathered SHALE	-	-	-	-	-	-	-	-	-	-
30	- - - -	S7 60	29.8 34.8														
					414.6 31.0		Gray, fine to medium grained SANDSTONE	-	-	-	-	-	-	-	-	-	-
					412.1 33.5		Gray, fine grained, SANDSTONE, interbedded layers of soft weathered SHALE	-	-	-	-	-	-	-	-	-	-
35	- - - -	S8 60	34.8 39.8		410.8 34.8		Gray, SHALE, very fine layering, interbedded layers of competent fine grainded SANDSTONE	-	-	-	-	-	-	-	-	-	-
40	- - - -	S9 22	39.8 44.8		405.8 39.8		Gray, fine grained, SANDSTONE, interbedded layers of soft weathered SHALE	-	-	-	-	-	-	-	-	-	-
45	- - - -	S10 60	44.8 49.8		400.8 44.8		Gray, SHALE, interbedded very fine layers of organics *brown/dark brown organic matter surfacing with drilling water, floats on water	-	-	-	-	-	-	-	-	-	-
					398.1 47.5		Dark gray, SHALE, thinly laminated	-	-	-	-	-	-	-	-	-	-

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CRR-AP-9

HALEY ALDRICH

TEST BORING REPORT

Boring No. CRR-AP-9
File No. 42796-001
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	Well Diagram	Stratum Change Elev/Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size*, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
50	- - - -	S11 60	49.8 54.8														
55	- - - -	S12 60	54.8 59.8		390.8 54.8		Dark gray, very fine grained, SANDSTONE, frequent very fine interbedded layers of organics,	-	-	-	-	-	-	-	-	-	-
60	- - - -	S13 60	59.8 64.8														
65	- - - -	S14 60	64.8 69.8														
					375.8 69.8 375.6 70.0		END OF BORING AT 69.8 FT										

H&A-TEST BORING-07-1 HA-LIB09-REV.GLB HA-TB+CORE+WELL-07-1.GDT \\GRN\COMMON\42796 - VECTREN\FB CULLEY\GINT\F.B. CULLEY LOGS.GPJ Apr 20, 17

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CRR-AP-9

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-10

Project	Nature and Extent, F. B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	ATC

File No.	129402-017
Sheet No.	1 of 2
Start	January 10, 2019
Finish	January 10, 2019
Driller	J. Mitchner
H&A Rep.	J. Yonts
Elevation	402.4
Datum	
Location	Between CCR-AP-5 and 4, N of EAP

	Casing	Sampler	Barrel
Type	HSA	S	
Inside Diameter (in.)	4.25	1 3/8	
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Diedrich D-50 Turbo
Bit Type: Cutting Head
Drill Mud: None
Casing: Spun
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model: -

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0							Gravel road base										
	4 4 4	S1 7	3.5 5.0	ML		398.4 4.0	Medium stiff, yellow-brown SILT with gravel (ML), mps 25 mm, stratified, no odor, moist	15	10	5	5	10	55				
5																	
	5 5 5 5	S2 13	8.5 10.5	ML		393.9 8.5	Stiff, brown SILT with sand (ML), mps 1.0 mm, stratified, no odor, moist				10	20	70				
				ML		393.4 9.0	Stiff, brown and red-brown SILT (ML), mps <0.075 mm, no structure, no odor, moist						100				
10				SM		392.6 9.8	Stiff, tan silty SAND (SM), mps 0.8 mm, no structure, no odor, dry					80	20				
				CL		392.2 10.2	Stiff, yellow-brown and dark brown CLAY (CL), mps <0.075 mm, stratified, no odor, moist						100				
							Note: Rig chatter at ~13 ft.										
	50/3"	S3 1	13.5 15.5			388.9 13.5	Hard, slightly weathered, gray, fine-grained SANDSTONE										
15																	
	38 50/2"	S4 13	18.5 20.5			383.9 18.5	Hard, highly weathered, gray-brown and black, fine-grained SANDSTONE interbedded with soft, highly weathered, gray, fine-grained SILTSTONE. Bedding very thin and horizontal, primary joint set horizontal, very close, rough, planar, discolored, open.										
20	19 50/3"	S5 12	20.5 22.5			381.9 20.5	Soft, highly weathered, gray, fine-grained SHALE interbedded with hard, highly weathered, gray-brown and black, fine-grained SANDSTONE. Bedding very thin and horizontal, primary joint set horizontal, very close, rough, planar, discolored, open.										
	49 50/4"	S6 10	22.5 24.5			379.4 23.0	Similar to above										
	50/4"	S7	24.5			377.9 24.5	Hard, highly weathered, gray-brown and black, fine-grained SANDSTONE interbedded with soft, highly weathered, gray, fine-										
25																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
2/13/19	49.56				

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	50.5
Rock Cored (ft)	-
Samples	19S

Boring No. CCR-AP-10

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†Note: Maximum particle size is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-10
File No. 129402-017
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
25		4	26.5				grained SILTSTONE. Bedding very thin and horizontal, primary joint set horizontal, very close, rough, planar, discolored, open.										
	50/5"	S8 5	26.5 28.5			375.9 26.5	Soft, slightly weathered, gray and brown, fine-grained SHALE interbedded with medium hard, slightly weathered, brown, fine-grained SANDSTONE. Bedding very thin and horizontal, primary joint set horizontal, very close, rough, planar, discolored, open.										
	50/3"	S9 3	28.5 30.5				Medium hard, slightly weathered, gray, fine-grained SHALE. Bedding very thin and horizontal, primary joint set horizontal, very close, smooth, planar, fresh, closed.										
30	39 50/2"	S10 8	30.5 32.5				Similar to above with frequent organic material Similar to above with no observed organic material										
	50/5"	S11 5	32.5 34.5														
35	50/2"	S12 2	34.5 36.5														
	26 50/2"	S13 8	36.5 38.5			365.9 36.5	Medium hard, slightly weathered, dark gray, fine-grained SHALE. Bedding very thin and horizontal, primary joint set horizontal, very close, smooth, planar, fresh, closed.										
	50/4"	S14 4	38.5 40.5														
40	50/3"	S15 3	40.5 42.5														
	50/4"	S16 4	42.5 44.5														
45	50/3"	S17 3	44.5 46.5														
	50/5"	S18 5	46.5 48.5														
	50/5"	S19 5	48.5 50.5														
50						351.9 50.5	BOTTOM OF EXPLORATION 50.5 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-10

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-11

Project	Nature and Extent, F. B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	ATC

File No.	129402-017
Sheet No.	1 of 2
Start	January 11, 2019
Finish	January 11, 2019
Driller	J. Mitchner
H&A Rep.	J. Yonts
Elevation	385.1
Datum	
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	
Inside Diameter (in.)	4.25	1 3/8	
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Diedrich D-50 Turbo
Bit Type: Cutting Head
Drill Mud: None
Casing: Spun
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model: -

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0				CL-ML			Dark brown to black CLAY and SILT (CL-ML), mps < 0.075 mm, no structure, no odor, dry, coal ash										
	3 3 3 5	S1 20	3.5 5.5	CL		381.6 3.5	Medium stiff, dark brown and olive CLAY with gravel (CL), mps 50 mm, stratified, no odor, moist, frequent coal	5	10	5			80				
5				ML		379.8 5.3	Medium stiff, light gray to white SILT (ML), mps 1 mm, no structure, no odor, moist, frequent coal				5	5	90				
10	2 4 9 2	S2 10	8.5 10.5	CL		376.6 8.5	Stiff, dark brown and olive CLAY with gravel (CL), mps 50 mm, stratified, no odor, moist, frequent coal and plant material	5	5	5		5	80				
15	2 2 2 2	S3 11	13.5 15.5	CL		371.6 13.5	Soft, dark brown and black CLAY with gravel (CL), mps 30 mm, stratified, no odor, wet, frequent coal and limestone gravel, occasional black woody material	10	10	5	5	5	65				
20	2 2 3 5	S4 12	18.5 20.5	CL		366.6 18.5	Medium stiff, brown and black CLAY with gravel (CL), mps 0.2 mm, stratified, no odor, wet					10	90				
25	3 4 6	S5 14	23.5 25.5	CL		361.6 23.5	Stiff, red-brown and gray CLAY (CL), mps < 0.075 mm, no structure, no odor, wet						100				

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary
Overburden (ft) 54.7
Rock Cored (ft) -
Samples 13S

Boring No. CCR-AP-11

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†Note: Maximum particle size is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-11
File No. 129402-017
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
25	8																
	4 6 10 11	S6 16	26.0 28.0	CL			Very stiff, red-brown CLAY (CL), mps 8 mm, no structure, no odor, wet		5	5	5	5	80				
	4 5 8 11	S7 24	28.0 30.0														
30	12 12 12 11	S8 24	30.0 32.0	CL			Very stiff, red-brown CLAY (CL), mps 8 mm, no structure, no odor, wet, frequent black woody material										
35	2 2 3 3	S9 24	34.0 36.0	ML		350.7 34.4	Medium stiff, brown and gray SILT with sand (ML), mps 1.0 mm, stratified, no odor, wet				10	20	70				
40	1 2 2 1	S10 20	39.0 41.0	SM		346.1 39.0	Soft, yellow-brown silty SAND (SM), mps 0.2 mm, no structure, no odor, wet, coarsening with depth					80	20				
45	2 1 1 2	S11 24	44.0 46.0	SM-CL		341.1 44.0	Soft, gray silty SAND (SM) interbedded with soft, gray CLAY (CL), mps 1.0 mm, no door, wet				20	60 5	20 95				
50	WOH 1 2 2	S12 24	49.0 51.0	SM-ML		336.1 49.0	Soft, gray silty SAND (SM) interbedded with soft, gray SILT (ML), mps 1.0 mm, no door, wet				10	70 10	20 90				
							Note: Rig chatter at ~53.0 ft bgs.										
	28 50/2"	S13 8	54.0 56.0			331.1 54.0 330.4 54.7	Medium hard, slightly weathered, gray, aphanitic SHALE. Bedding very thin and horizontal, primary joint set horizontal, very close, smooth, planar, fresh, closed.										
							BOTTOM OF EXPLORATION 54.7 FT BGS										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-11

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-5I

Project	Nature and Extent, F. B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	ATC

File No.	129402-017
Sheet No.	1 of 5
Start	January 7, 2019
Finish	January 9, 2019
Driller	J. Mitchner
H&A Rep.	J. Yonts
Elevation	395.0
Datum	
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	Steel
Inside Diameter (in.)	4.25	1 3/8	1 7/8
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

- Rig Make & Model: Diedrich D-50 Turbo
- Bit Type: Cutting Head
- Drill Mud: None
- Casing: Spun
- Hoist/Hammer: Winch Automatic Hammer
- PID Make & Model: -

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							Refer to Soil Boring CCR-AP-5 for lithology from 0-40 ft.										
5																	
10																	
15																	
20																	
25																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
2/13/19	10.18				

Sample ID

- O - Open End Rod
- T - Thin Wall Tube
- U - Undisturbed Sample
- S - Split Spoon Sample

Well Diagram

- Riser Pipe
- Screen
- Filter Sand
- Cuttings
- Grout
- Concrete
- Bentonite Seal

Summary

Overburden (ft)	49.1
Rock Cored (ft)	36.2
Samples	5S, 7C

Boring No. CCR-AP-5I

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†Note: Maximum particle size is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-5I
File No. 129402-017
Sheet No. 2 of 5

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
25																	
30																	
35																	
40	5 1 3	S1 6	39.0 40.5				Medium, highly weathered, brown, medium-grained SANDSTONE, wet										
	3 5 50/4"	S2 10	40.5 42.5				Note: Rig chatter/bounce at ~41 ft.										
	9 32 34 34	S3 10	42.5 44.5			351.5 43.5	Soft, highly weathered, black, fine-grained COAL, moist										
						351.0 44.0	Soft, highly weathered, gray, fine-grained SILTSTONE, moist										
45	10 14 17 22	S4 24	44.5 46.5			349.7 45.3	Soft, highly weathered, brown, tan, gray and yellow, aphanitic SHALE, moist										
						348.3 46.7	Very soft, completely weathered, brown and tan, aphanitic SHALE, moist										
	9 50/1"	S5 7	46.5 48.5				Hard, highly weathered, gray, fine-grained LIMESTONE with brown CLAY, wet to moist										
						345.9 49.1	Note: Rig chatter at ~47 ft.										
50		C1 55	50.0 55.0			344.7 50.3	Hard, fresh to slightly weathered, greenish gray to light gray, fine-grained LIMESTONE. No bedding, moderately dipping fractures, rough, tan discoloration, open, bioturbated										
							Soft, moderately weathered, gray and brown, fine-grained SHALE. Bedding extremely thin and horizontal, cleavage joints horizontal, extremely close, smooth, fresh, tight										
							Medium hard, moderately weathered, gray, fine-grained SHALE. Bedding extremely thin and horizontal, cleavage joints horizontal, extremely close, smooth, discolored, tight. Thin occasional pyrite veins										
55	50/2"	S6 2	55.0 57.0				Similar to above except no pyrite, aphanitic and moist										
	50/3"	S7 3	57.0 59.0														
	50/5"	S8 5	59.0 61.0			336.0 59.0	Soft, moderately weathered, tan and gray, fine-grained SHALE. Bedding extremely thin and horizontal, cleavage joints horizontal, extremely close, smooth, discolored, tight.										
60																	
	50/4"	S9 4	61.0 63.0			334.0 61.0	Medium hard, moderately weathered, gray, fine-grained SHALE. Bedding extremely thin and horizontal, cleavage joints horizontal,										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-5I

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-5I
File No. 129402-017
Sheet No. 3 of 5

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
							extremely close, smooth, discolored, tight.										
	50/5"	S10 5	63.0 64.3														
65		C2 12	64.3 65.3				Medium hard, fresh, dark gray to gray, aphanitic SHALE. Bedding extremely thin and horizontal, cleavage joints horizontal, extremely close, smooth, fresh, tight										
		C3 50	65.3 70.3														
70		C4 60	70.3 75.3			324.7 70.3	Hard, fresh, dark gray to gray, aphanitic organic SHALE interbedded with gray, fine-grained SILTSTONE. Bedding extremely thin and horizontal, cleavage joints horizontal, extremely close to very close, smooth, fresh, tight. Trace plant fossils in SHALE 3 to 5 mm dissolution zone filled with pyrite										
75		C5 60	75.3 80.3			319.7 75.3	Similar to above except no visible fossils										
80		C6 60	80.3 85.3														
85						309.7 85.3	BOTTOM OF EXPLORATION 85.3 FT.										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-5I

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-6I

Project	Nature and Extent, F. B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	ATC

	Casing	Sampler	Barrel	Drilling Equipment and Procedures
Type	HSA	S		Rig Make & Model: Geoprobe 8040DT
Inside Diameter (in.)	4.25	1 3/8		Bit Type: Cutting Head; Drill Mud: None
Hammer Weight (lb)	-	140	-	Casing: Spun
Hammer Fall (in.)	-	30	-	Hoist/Hammer: Winch Automatic Hammer; PID Make & Model: -

File No.	129402-017
Sheet No.	1 of 3
Start	November 15, 2018
Finish	November 16, 2018
Driller	Z. Vaughen
H&A Rep.	S. Lewis
Elevation	397.2
Datum	
Location	See Plan

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							Refer to Test Boring CCR-AP-6 for lithology from 0-38 ft.										
5																	
10																	
15																	
20																	
25																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
2/13/19	20.09				

Sample ID
O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram
Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	75.0
Rock Cored (ft)	-
Samples	8S

Boring No. CCR-AP-6I

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†Note: Maximum particle size is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-6I
File No. 129402-017
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
25																	
30																	
35																	
	3 1 2 4	S1 20	38.0 40.0	CL		359.2 38.0	Soft, gray CLAY (CL) with occasional small pockets of gray poorly-graded SAND (SP), mps 0.40 mm, laminated, no odor, moist						100				
40																	
	WOH WOH WOH WOH	S2 24	43.0 45.0	CL		354.2 43.0	Very soft, gray sandy CLAY (CL), mps 0.3 mm, no structure, no odor, wet, frequent black woody material					30	70				
45																	
	WOH 7 1 2	S3 24	48.0 50.0	CL		349.2 48.0	Very soft, brown-gray sandy CLAY (CL), mps 0.3 mm, no structure, no odor, wet, frequent mica, frequent black woody material					30	70				
50																	
	WOH 3 7 9	S4 24	53.0 55.0	CL			Stiff, brown-gray sandy CLAY (CL), mps 0.3 mm, stratified, no odor, wet, frequent mica, abundant black woody material					30	70				
				SM		343.0 54.2	Loose, brown-gray silty SAND with gravel (SM), mps 60 mm, no structure, no odor, wet, well rounded gravel and sand	15	15	15	20	15	20				
55																	
	3 6 8 8	S5 13	58.0 60.0	CL		339.2 58.0	Very soft, brown-gray sandy CLAY (CL), mps 0.3 mm, no structure, no odor, wet, frequent mica, frequent black woody material					30	70				
				CL		338.2 59.0	Stiff, brown-gray sandy CLAY (CL), mps 0.3 mm, stratified, no odor, wet, frequent mica, abundant black woody material					30	70				
60						337.2 60.0											

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-6I

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-6I
File No. 129402-017
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
	8 9 12 13	S6 19	63.0 65.0	CL			Very stiff, gray and brown sandy CLAY (CL), mps 0.3 mm, stratified, no odor, wet					30	70				
65				SW-SM		333.2 64.0	Medium dense, brown well-graded SAND with silt and gravel (SW-SM), mps 35 mm, no structure, no odor, wet, well rounded gravel and sand	10	20	20	20	20	10				
	4 9 13 16	S7 12	68.0 70.0	SP		329.2 68.0	Medium dense, brown-gray poorly-graded SAND (SP), mps 25 mm, no structure, no odor, wet, well rounded gravel and sand	5	5	5	35	45	10				
70																	
75	8 11 15 26	S8 14	73.0 75.0			322.2 75.0	BOTTOM OF EXPLORATION 75.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-6I

HALEY ALDRICH

TEST BORING REPORT

Boring No. CCR-AP-8I

Project	Nature and Extent, F. B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	ATC

File No.	129402-017
Sheet No.	1 of 3
Start	November 14, 2018
Finish	November 15, 2018
Driller	Z. Vaughen
H&A Rep.	S. Lewis
Elevation	393.9
Datum	
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	
Inside Diameter (in.)	4.25	1 3/8	
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Geoprobe 8040DT
Bit Type: Cutting Head
Drill Mud: None
Casing: Spun
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model: -

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
0							Refer to Test Boring CCR-AP-8 for lithology from 0-38 ft.										
5																	
10																	
15																	
20																	
25																	

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water
2/13/19	16.79				

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft)	70.0
Rock Cored (ft)	-
Samples	7S

Boring No. CCR-AP-8I

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Toughness**: L - Low M - Medium H - High **Plasticity**: N - Nonplastic L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†Note: Maximum particle size is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-8I
File No. 129402-017
Sheet No. 2 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
25																	
30																	
35																	
	7 5 8 7	S1 12	38.0 40.0	CL		355.9 38.0	Stiff, gray lean CLAY (CL), mps < 0.075 mm, no structure, no odor, moist						100				
40																	
	3 4 5 7	S2 24	43.0 45.0	CL		350.9 43.0	Stiff, brown-gray lean CLAY (CL), mps < 0.075 mm, stratified, no odor, moist, frequent woody material						100				
45																	
	WOH WOH 3 3	S3 24	48.0 50.0	CL			Stiff, brown-gray lean CLAY (CL), mps < 0.075 mm, stratified, no odor, moist, abundant woody material						100				
50																	
	WOH WOH 3 3	S4 24	53.0 55.0	CL		339.9 54.0	Stiff, brown-gray lean CLAY (CL) with occasional gray poorly-graded SAND (SP) pockets, stratified, no odor, moist, abundant woody material						100				
55							Note: Heaving sands at 58 ft. fill augers 5 ft.										
	2 WOH 1 WOH	S5 24	58.0 60.0	SP		335.9 58.0	Very loose, gray poorly-graded SAND (SP), mps 1.5 mm, no structure, no odor, wet				30	70					
				SW		334.4 59.5	Very loose, gray well-graded SAND with gravel (SW), mps 60 mm, no structure, no odor, wet	20	20	20	10	30					
60																	

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-8I

TEST BORING REPORT

HALEY ALDRICH

Boring No. CCR-AP-8I
File No. 129402-017
Sheet No. 3 of 3

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Well Diagram	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
	5 3 10 13	S6 11	63.0 65.0	SP		330.9 63.0	Medium dense, gray poorly-graded SAND (SP), mps 1.5 mm, no structure, no odor, wet, frequent coal fragments, subrounded sand				30	70					
65				SP		328.9 65.0	Medium dense, gray poorly-graded SAND (SM), mps 1.5 mm, no structure, no odor, wet, frequent coal fragments, occasional highly weathered gray shale, frequent black woody material starting at 69.5 ft, subrounded sand				30	70					
	1 1 9 12	S7 13	68.0 70.0														
70						323.9 70.0	BOTTOM OF EXPLORATION 70.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

Boring No. CCR-AP-8I

HALEY ALDRICH

TEST BORING REPORT

Boring No. HASB-1

Project	Nature and Extent, F. B. Culley Generating Station
Client	Southern Indiana Gas & Electric Company
Contractor	ATC

File No.	129402-017
Sheet No.	1 of 2
Start	November 16, 2018
Finish	November 16, 2018
Driller	Z. Vaughen
H&A Rep.	S. Lewis
Elevation	
Datum	
Location	See Plan

	Casing	Sampler	Barrel
Type	HSA	S	
Inside Diameter (in.)	4.25	1 3/8	
Hammer Weight (lb)	-	140	-
Hammer Fall (in.)	-	30	-

Drilling Equipment and Procedures

Rig Make & Model: Geoprobe 8040DT
Bit Type: Cutting Head
Drill Mud: None
Casing: Spun
Hoist/Hammer: Winch Automatic Hammer
PID Make & Model: -

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Toughness	Plasticity	Strength
0		S1 60	0.0 5.0	CL		Tanish-brown CLAY (CL), mps 10 mm, no odor, moist	5	5	5	5	5	75				
5		S2 60	5.0 10.0	CL		Similar to above, except wood fragments present										
10		S3 24	10.0 15.0													
15		S4 60	15.0 20.0	CL	15.0	Brown CLAY (CL), no odor, moist										
					17.0	Highly weathered, gray SHALE, extremely thin bedding										
20		S5 30	20.0 22.0			Refusal with macrocore, switch to augers										
	50/2"	S6 2	22.0 22.2			Highly weathered, gray SHALE with frequent highly weathered gray LIMESTONE fragments										
	50/2"	S7 2	24.0		24.0	Slightly weathered, gray LIMESTONE										
25																

Water Level Data

Date	Time	Elapsed Time (hr.)	Depth (ft) to: Bottom of Casing	Bottom of Hole	Water

Sample ID

O - Open End Rod
T - Thin Wall Tube
U - Undisturbed Sample
S - Split Spoon Sample

Well Diagram

Riser Pipe
Screen
Filter Sand
Cuttings
Grout
Concrete
Bentonite Seal

Summary

Overburden (ft) 40.0
Rock Cored (ft) -
Samples 7S

Boring No. HASB-1

Field Tests: **Dilatancy**: R - Rapid S - Slow N - None **Plasticity**: N - Nonplastic L - Low M - Medium H - High
Toughness: L - Low M - Medium H - High **Dry Strength**: N - None L - Low M - Medium H - High V - Very High

†Note: Maximum particle size is determined by direct observation within the limitations of sampler size.

Note: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.

H&A-TEST BORING-09 REV 132892_HA-LIB09.GLB HA-TB+CORE+WELL-07-2 W FENCE.GDT G:\129420 VECTREN\PROJECT DATA\FIELD DATA\04_GINT\FB CULLEY\EAST ASH POND\2019_0328_HAI_N&E FBCULLEY_D1.GPJ Jul 16, 19

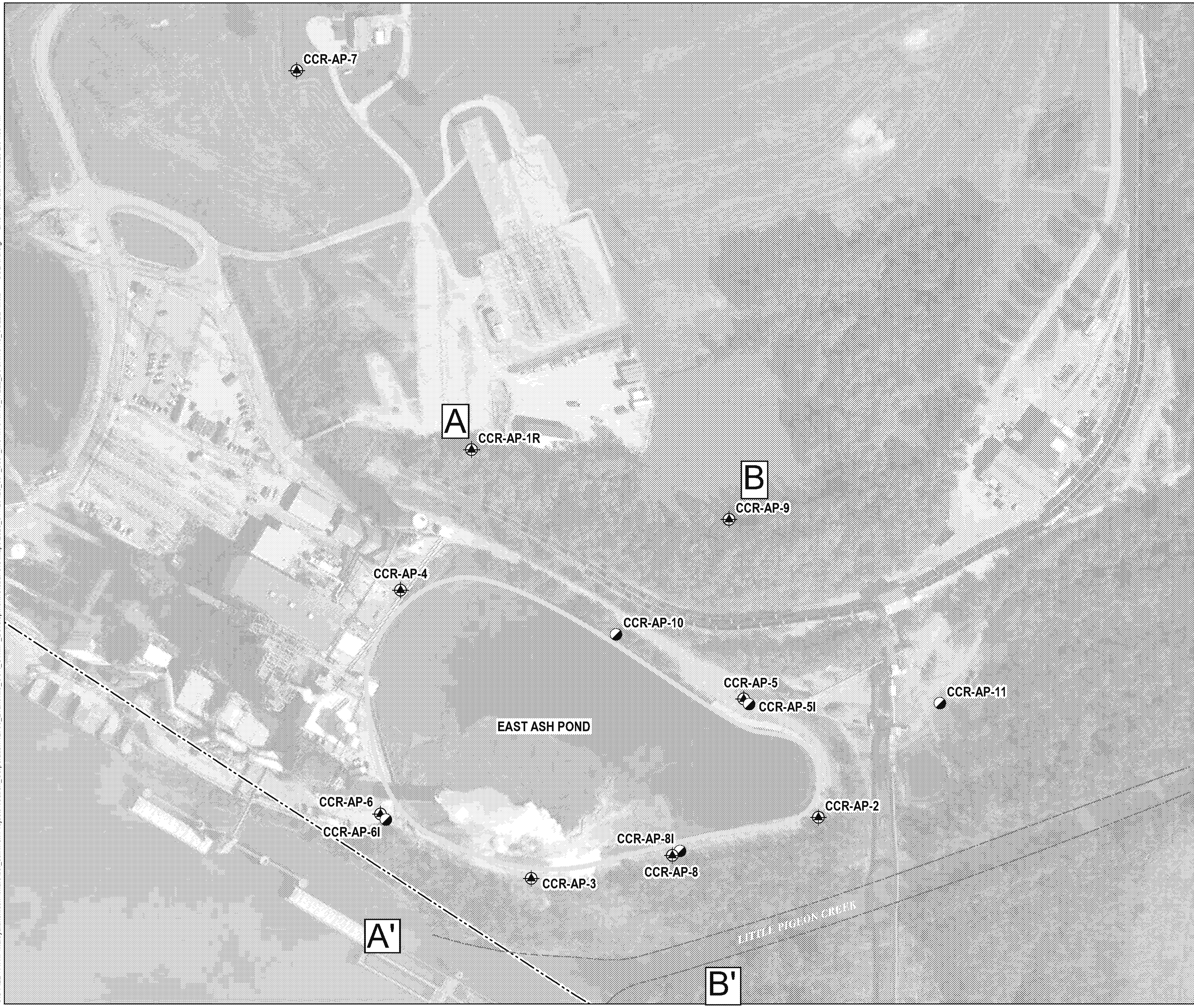
HALEY ALDRICH

TEST BORING REPORT

Boring No. HASB-1
File No. 129402-017
Sheet No. 2 of 2

Depth (ft)	Sampler Blows per 6 in.	Sample No. & Rec. (in.)	Sample Depth (ft)	USCS Symbol	Stratum Change Elev/Depth (ft)	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Density/consistency, color, GROUP NAME, max. particle size†, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel % Coarse	Gravel % Fine	Sand % Coarse	Sand % Medium	Sand % Fine	% Fines	Field Test Dilatancy	Field Test Toughness	Field Test Plasticity	Field Test Strength
25			24.2			Note: No sample collected past 24.2 ft. Continued notes based on observations from auger cutting.										
30						Note: Rig chatter at 32 ft.										
						Gray LIMESTONE continues in auger cuttings										
35						Note: Rig chatter stop at 35 ft.										
						Black COAL and dark gray SHALE in auger cuttings when cutting head is at 40 ft.										
40					40.0	BOTTOM OF EXPLORATION 40.0 FT										

NOTE: Soil identification based on visual-manual methods of the USCS as practiced by Haley & Aldrich, Inc.



LEGEND

CCR-AP-11 MONITORING WELL

CCR-AP-6I NATURE AND EXTENT MONITORING WELL

APPROXIMATE UNIT BOUNDARY

APPROXIMATE PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS ARE APPROXIMATE
2. CCR COAL COMBUSTION RESIDUALS
3. AERIAL IMAGERY SOURCE: ESRI

N

0 220 440

SCALE IN FEET

HALEY ALDRICH

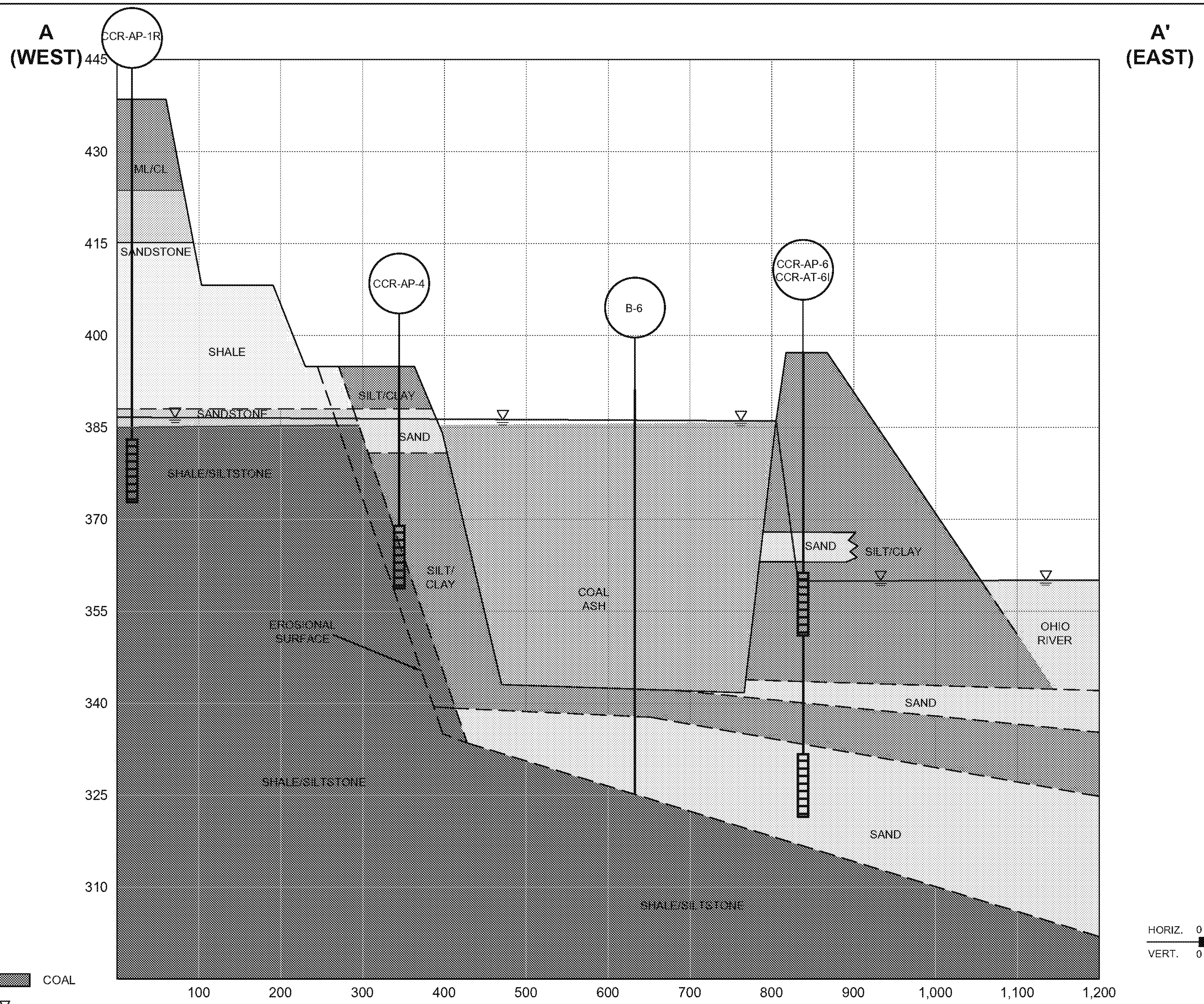
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

GROUNDWATER MONITORING WELL LOCATIONS

JANUARY 2020

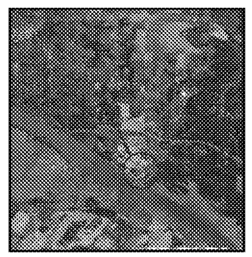
FIGURE 1

GIS FILE PATH: \\haleyaldrich.com\share\bol_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2020_01\129420_001_0001_MONITORING_WELL_LOCATIONS_CULLEY.mxd — USER: afeigl — LAST SAVED: 1/10/2020 2:01:30 PM



LEGEND

- COAL ASH
- LIMESTONE
- POORLY GRADED AND WELL GRADED SANDS
- SILT/CLAY
- SHALE
- SANDSTONE
- SHALE/SANDSTONE
- SCREEN LOCATION
- COAL
- GROUNDWATER LEVEL
- INTERPRETED SOIL/BEDROCK LEVELS
- BORING ID/LOCATION WITH GROUND SURFACE ELEVATION



PROJECT LOCATION

TOPO SOURCE: IMAGE DATED 2019 TAKEN ELECTRONICALLY FROM BING MAPS

PREPARED FOR:

SIGECO
F.B. CULLEY GENERATION STATION
EAST ASH POND

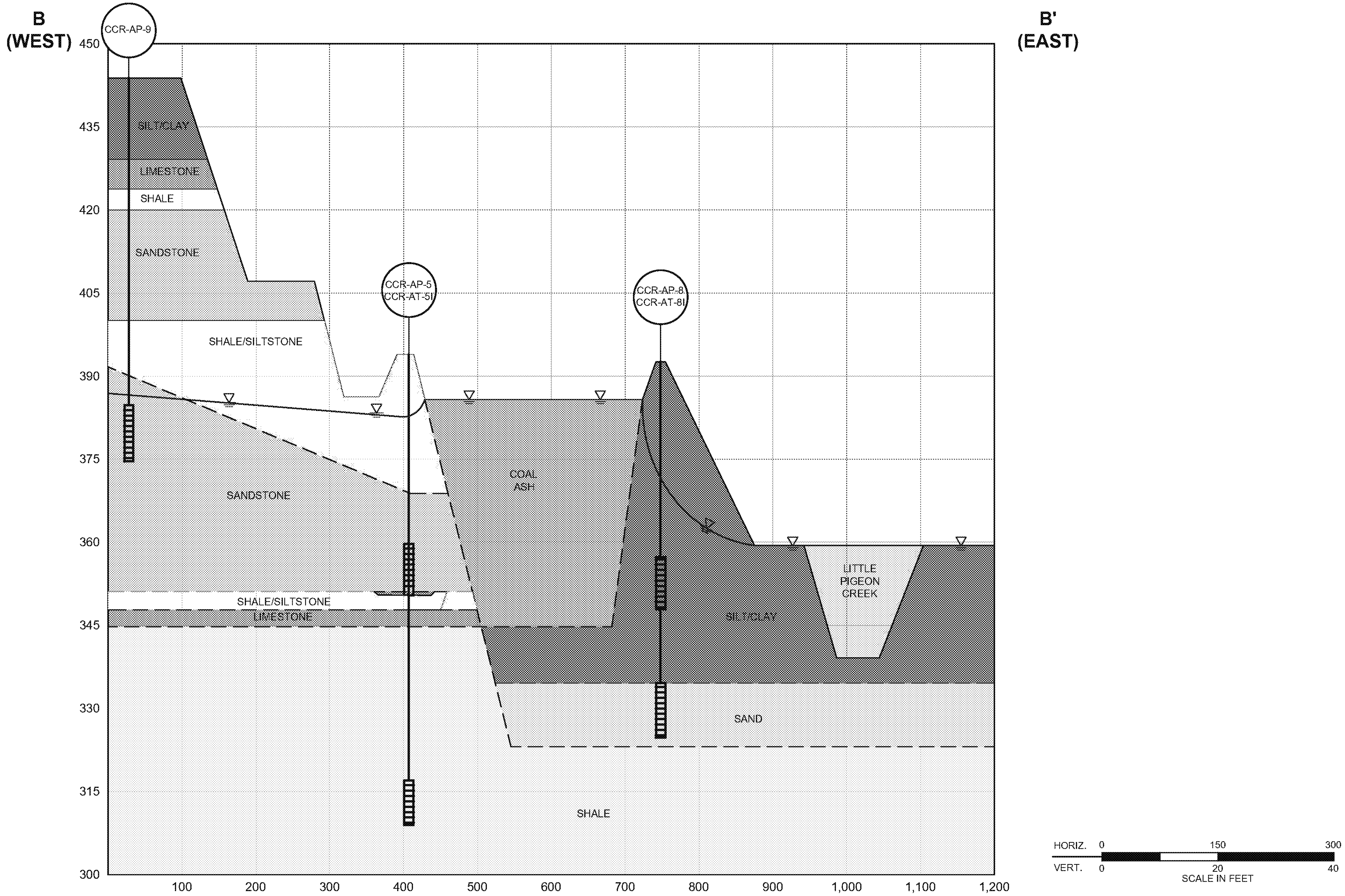
F.B. CULLEY GENERATION STATION
NEWBURGH, INDIANA

FIGURE 1A

EXISTING CONDITIONS CROSS SECTION A-A' EAST ASH POND

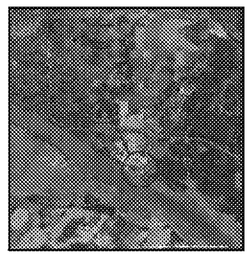
PROJECT: 129420	BY: OS/KC	REVISIONS:
DATE: OCT 2020	CHECKED: SL	

HALEY & ALDRICH



LEGEND

- COAL ASH
- LIMESTONE
- WELL GRADED AND POORLY GRADED SANDS
- SILT/CLAY
- SHALE
- SANDSTONE
- SHALE/SANDSTONE
- SCREEN LOCATION
- GROUNDWATER LEVEL
- INTERPRETED SOIL/BEDROCK LEVELS
- BORING ID/LOCATION WITH GROUND SURFACE ELEVATION



PROJECT LOCATION

TOPO SOURCE: IMAGE DATED 2019 TAKEN ELECTRONICALLY FROM BING MAPS

PREPARED FOR:

SIGECO
F.B. CULLEY GENERATION STATION
EAST ASH POND

F.B. CULLEY GENERATION STATION
NEWBURGH, INDIANA

FIGURE 1B

EXISTING CONDITIONS CROSS SECTION B-B' EAST ASH POND

PROJECT: 129420	BY: OS/KC	REVISIONS:
DATE: OCT 2020	CHECKED: SL	

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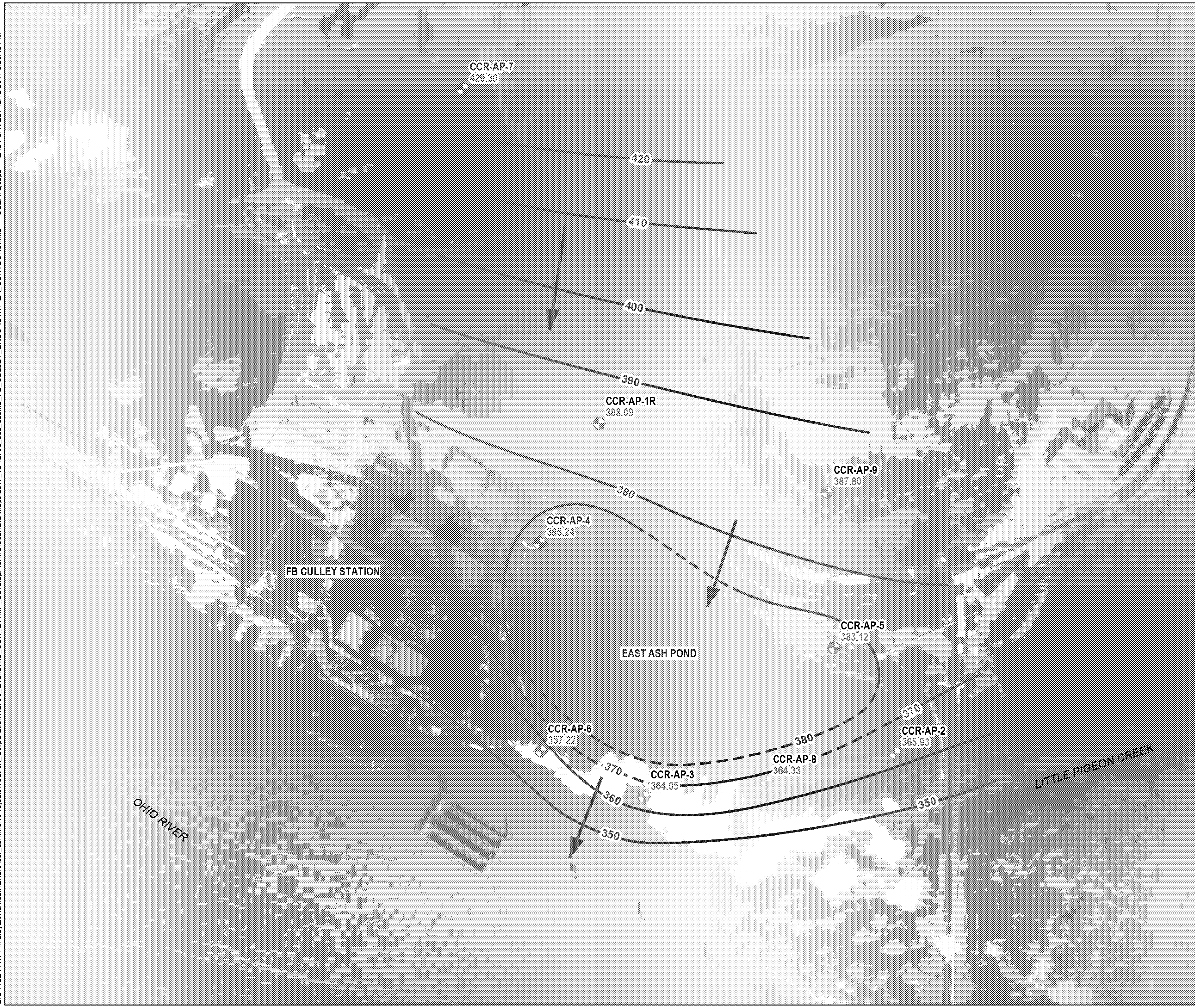
Appendix G
Groundwater Flow Direction



UPGRADIENT MONITORING

DOWNGRADIENT MONITORING

POTENTIOMETRIC FLOW LINE, DASHED WHERE

GROUNDWATER FLOW

NOTES

1. AERIAL IMAGERY SOURCE: ESRI
2. LOCATIONS DERIVED FROM THREE I DESIGN DATA.
3. GROUNDWATER ELEVATIONS MEASURED 6 APRIL 2017

0 500
SCALE IN FEET

HALEY ALDRICH

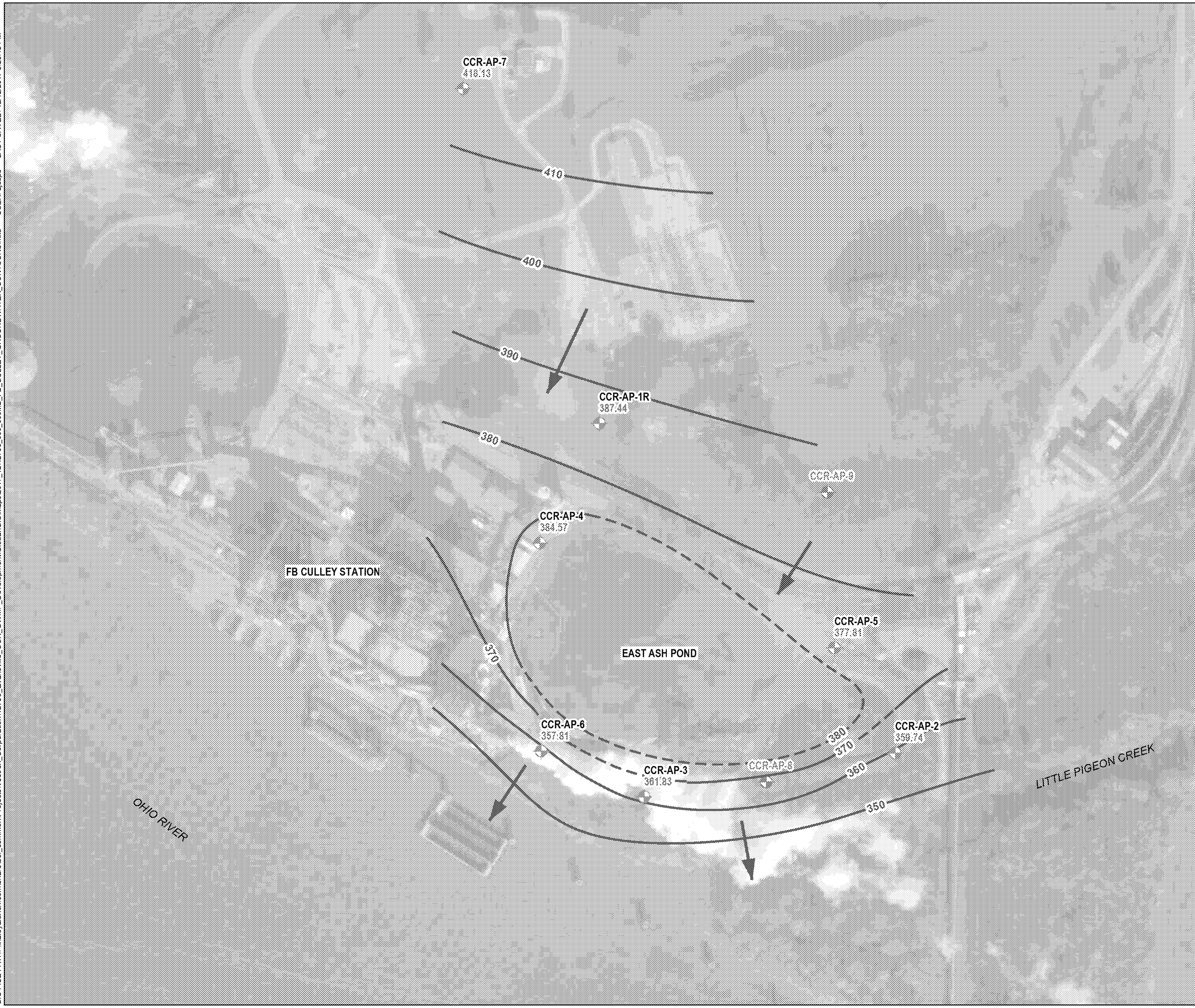
VECTREN CORPORATION
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, INDIANA

SEASONAL HIGH WATER
TABLE CONFIGURATION
APRIL 6 2017

JANUARY 2018

FIGURE 2

GIS FILE PATH: \\haleyaldrich.com\share\bol_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2017_12\42796_000_000MB_FB_CULLEY_GROUNDWATER_CONTOURS.mxd — USER: ajospe — LAST SAVED: 12/12/2017 5:26:45 PM



LEGEND

- UPGRADIENT MONITORING WELL
- DOWNGRADIENT MONITORING WELL
- MONITORING WELL NOT USED TO CONTOUR
- POTENTIOMETRIC FLOW LINE, DASHED WHERE INFERRED
- GROUNDWATER FLOW DIRECTION

NOTES

1. AERIAL IMAGERY SOURCE: ESRI
2. LOCATIONS DERIVED FROM THREE I DESIGN DATA.
3. GROUNDWATER ELEVATIONS MEASURED 28 OCTOBER 2016

HALEY ALDRICH

VECTREN CORPORATION
F.B. CULLEY GENERATING STATION
3711 DARLINGTON ROAD
NEWBURGH, INDIANA

SEASONAL LOW WATER TABLE CONFIGURATION OCTOBER 28 2016

JANUARY 2018

FIGURE 2

GIS FILE PATH: \\haleyaldrich.com\share\bol_common\Projects\Vectren_Corporation\42796_Evansville_CCR_GWMP_Development\Global\GIS\Maps\2017_12\42796_000_000MB_FB_CULLEY_GROUNDWATER_CONTOURS.mxd — USER: ajospe — LAST SAVED: 12/12/2017 5:26:45 PM

Appendix H
Groundwater Monitoring Analytical Results

TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Downgradient								
Location Name	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2	CCR-AP-2
Sample Name	CCR-AP-2-20160610	CCR-AP-2-20160812	CCR-AP-2-20161028	CCR-AP-2-20161207	CCR-AP-2-20170208	CCR-AP-2-20170406	CCR-AP-2-20170607	CCR-AP-2-20170928	CCR-AP-2-20171117
Sample Date	06/10/2016	08/12/2016	10/28/2016	12/07/2016	02/08/2017	04/06/2017	06/07/2017	09/28/2017	11/17/2017
Lab Sample ID	180-55667-2	180-57631-2	180-60350-2	180-61530-2	180-63329-2	180-65041-4	180-67233-2	180-70838-6	180-72640-2
Water Level (ft amsl)	360.81	360.09	359.74	360.29	361.42	365.93	360.28	359.91	360.97
Monitoring Program	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Detection
Field Parameters									
Temperature (Deg C)	23.78	22.2	17.36	16.08	11.12	14	21.33	20.28	13.92
Turbidity, Field (FNU)	-	-	-	-	-	-	-	-	-
Dissolved Oxygen, Field (mg/L)	2.34	4.46	4.49	6.85	8.25	3.69	2.93	1.53	4.21
Conductivity, Field (mS/cm)	2.05436	2.149	2.05359	1.6746	0.78602	2.65509	1.99948	2.18197	2.18306
ORP, Field (mv)	42.71	40	-67.04	-73.8	17.3	10.57	59.36	141.67	143.3
Turbidity, Field (NTU)	3729.19	1083	375.23	6180	2286	2940	2131	3019	2084
pH, Field (su)	6.56	7.61	7.71	6.63	8.14	7.41	7.85	6.51	7.61
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	15	12	11	12	12	12	12	7.8	14
Calcium, Total	200	230	220 J-	240	260 J-	240 J+	240	220	260
Chloride (mg/L)	72	73	73 J+	75	83	89	81	110	120
Fluoride (mg/L)	0.16 J+	0.28	0.23	0.3 J+	0.26 J+	0.29	0.3 J	0.28	0.11
Sulfate (mg/L)	530 J-	730	540 J+	680	570	600	510	610	680 J-
pH (lab) (su)	7.26 J	7.4 J	6.7 J	6.8 J	7 J	6.8 J	6.8 J	6.9 J	7 J
Total Dissolved Solids (TDS) (mg/L)	1700	1700	1600	1600	1500	1600	1600	1700	1600
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	0.002	0.002 U	0.002 U	0.00024 J	0.002 U	0.002 U	0.002 U	0.0017 J	0.01 U
Arsenic, Total	0.0018	0.0016	0.0044	0.003	0.0035	0.0018	0.0066	0.017	0.0066
Barium, Total	0.055	0.038	0.09	0.14	0.12	0.052	0.27	0.44	0.17
Beryllium, Total	0.00014 J	0.00015 J	0.00066 J	0.00056 J	0.00038 J	0.00032 J	0.00099 J	0.0027	0.0012 J
Cadmium, Total	0.00055 J	0.00023 J	0.00053 J	0.00048 J	0.00038 J	0.00011 J	0.00078 J	0.00073 J	0.005 U
Chromium, Total	0.0035	0.003	0.013	0.011	0.0084	0.0037	0.025	0.056	0.021
Cobalt, Total	0.0073	0.0096	0.016 J	0.012	0.014	0.011	0.021	0.038	0.018
Lead, Total	0.0023	0.0028	0.0096 J	0.006	0.0057	0.0026 J+	0.016	0.051	0.012
Lithium, Total	0.05 U	0.05 U	0.017 J	0.05 U	0.01 J	0.05 U	0.023 J	0.023 J	0.25 U
Molybdenum, Total	0.0018 J	0.00099 J	0.0014 J	0.0015 J	0.0017 J	0.00094 J	0.0024 J	0.0051	0.004 J
Selenium, Total	0.00044 J	0.00076 J	0.0013 J	0.005 U	0.005 U	0.005 UJ	0.005 U	0.0044 J	0.025 U
Thallium, Total	0.000048 J	0.000048 J	0.00014 J	0.00016 J	0.00017 J	0.001 U	0.00026 J	0.00068 J	0.00079 J
Mercury, Total	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Radiological (pCi/L)									
Radium-226	0.222 J ± 0.145	1.22 ± 0.355	0.731 ± 0.526	2.01 ± 1.16	0.672 ± 0.334	1.03 ± 0.385	0.894 ± 0.361	0.730 ± 0.327	0.266 ± 0.151
Radium-226 & 228	0.764 U ± 0.590	2.32 ± 1.08	1.38 J ± 0.750	2.72 J ± 1.61	1.68 ± 0.684	2.47 J ± 1.01	3.29 ± 1.13	1.91 J+ ± 1.11	0.850 J+ ± 0.522
Radium-228	0.542 U ± 0.572	1.09 U ± 1.02	0.648 U ± 0.534	0.707 U ± 1.12	1.00 ± 0.596	1.44 ± 0.934	2.40 ± 1.07	1.18 U ± 1.06	0.585 U ± 0.500

ABBREVIATIONS AND NOTES:
- CCR: Coal Combustion Residuals
- CFR: Code of Federal Regulations
- ft amsl: feet above mean sea level
- MCL: Maximum Contaminant Level
- mg/L: milligram per liter
- mS/cm: milliSiemen per centimeter
- mv: millivolt
- NA: Not Applicable
- NTU: Nephelometric Turbidity Units
- pCi/L: picoCurie per liter
- su: standard units
- USEPA: United States Environmental Protection Agency

QUALIFIERS:
- J: value is estimated
- J+: value is estimated with a potentially high bias
- J-: value is estimated with a potentially low bias
- R: value is rejected
- U: Not detected value is the laboratory reporting limit

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Downgradient								
Location Name	CCR-AP-3	CCR-AP-3	CCR-AP-3	CCR-AP-3	CCR-AP-3	CCR-AP-3	CCR-AP-3	CCR-AP-3	CCR-AP-3
Sample Name	CCR-AP-3-20160610	CCR-AP-3-20160815	CCR-AP-3-20161028	CCR-AP-3-20161207	CCR-AP-3-20170208	CCR-AP-3-20170406	CCR-AP-3-20170607	CCR-AP-3-20170928	CCR-AP-3-20171117
Sample Date	06/10/2016	08/15/2016	10/28/2016	12/07/2016	02/08/2017	04/06/2017	06/07/2017	09/28/2017	11/17/2017
Lab Sample ID	180-55667-3	180-57631-3	180-60350-3	180-61530-3	180-63329-3	180-65041-5	180-67233-3	180-70838-7	180-72640-3
Water Level (ft amsl)	363.31	362.21	361.83	361.92	364.22	364.05	363.8	362.09	362.36
Monitoring Program	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Detection
Field Parameters									
Temperature (Deg C)	25.51	21.8	18.91	14.9	11.52	14.85	19.1	19.39	12.84
Turbidity, Field (FNU)	-	-	-	-	-	-	-	-	-
Dissolved Oxygen, Field (mg/L)	0.49	4.41	4.52	4.05	8.44	6.11	2.71	2.1	4.04
Conductivity, Field (mS/cm)	1.79964	1.827	1.81571	1.5418	1.84566	1.91137	1.71067	1.78845	1.79086
ORP, Field (mv)	-152.01	-92	-162.25	-200.5	-109.73	-34.59	-124.19	-133.73	-123.58
Turbidity, Field (NTU)	37.7	111.2	175.6	706.49	202.52	110.58	169.96	55.84	245.28
pH, Field (su)	6.83	6.8	7.68	7.12	7.63	7.39	6.96	6.99	7.08
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	0.18	0.15 J+	0.16	0.17 J+	0.18 J+	0.2	0.27 U	0.12	0.19 U
Calcium, Total	160	170	190 J-	190	190 J-	180 J+	200	180	190
Chloride (mg/L)	26	26	27 J+	26	23	25	25	25	25
Fluoride (mg/L)	0.1 U	0.93	0.31	0.5	0.39	0.57	0.55	0.45	0.14
Sulfate (mg/L)	1.3 J-	R	1.1 J+	1 U	0.67 J	1 U	0.56 J	0.48 J	0.82 J-
pH (lab) (su)	7.17 J	7.6 J	7 J	7.2 J	7.2 J	7.1 J	7.2 J	7.1 J	7.4 J
Total Dissolved Solids (TDS) (mg/L)	1000	1000	1000	970	1000	1000	1200	1000	970
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	0.002 U	0.002 U	0.002 U	0.00031 J	0.002 U	0.002 U	0.002 U	0.00058 J	0.002 U
Arsenic, Total	0.058	0.072	0.071	0.068	0.086	0.08	0.077	0.066	0.067
Barium, Total	0.41	0.38	0.4	0.43	0.46	0.42	0.44	0.39	0.4
Beryllium, Total	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Cadmium, Total	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Chromium, Total	0.0021	0.0018 J	0.002	0.0023	0.002	0.0021	0.002 U	0.002 U	0.0021
Cobalt, Total	0.0094	0.008	0.0076 J	0.007	0.0072	0.0063	0.0062	0.0057	0.0056
Lead, Total	0.00041 J	0.00039 J	0.001 UJ	0.00066 J	0.00035 J	0.00048 J+	0.001 U	0.00098 J	0.00051 J
Lithium, Total	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Molybdenum, Total	0.011	0.014	0.014	0.014	0.013	0.011	0.012	0.01	0.011
Selenium, Total	0.0015 J	0.00062 J	0.0018 J	0.0019 J	0.002 J	0.0018 J-	0.0018 J	0.0016 J	0.0017 J
Thallium, Total	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0001 J
Mercury, Total	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Radiological (pCi/L)									
Radium-226	0.657 J ± 0.201	0.865 ± 0.232	1.15 ± 0.477	0.789 ± 0.398	0.373 U ± 0.293	0.450 ± 0.144	0.582 ± 0.158	0.411 ± 0.136	0.626 ± 0.162
Radium-226 & 228	1.75 ± 0.615	1.65 ± 0.627	1.97 ± 0.589	1.72 ± 0.623	0.862 U ± 0.680	1.09 ± 0.373	1.83 ± 0.456	R	R
Radium-228	1.10 ± 0.581	0.784 U ± 0.583	0.819 ± 0.347	0.932 ± 0.480	0.489 U ± 0.614	0.644 ± 0.344	1.25 ± 0.427	R	R

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CCR: Coal Combustion Residuals
CFR: Code of Federal Regulations
ft amsl: feet above mean sea level
MCL: Maximum Contaminant Level
mg/L: milligram per liter
mS/cm: milliSiemen per centimeter
mv: millivolt
NA: Not Applicable
NTU: Nephelometric Turbidity Units
pCi/L: picoCurie per liter
su: standard units
USEPA: United States Environmental Protection Agency

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J: value is estimated
J+: value is estimated with a potentially high bias
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- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Downgradient								
Location Name	CCR-AP-4	CCR-AP-4	CCR-AP-4	CCR-AP-4	CCR-AP-4	CCR-AP-4	CCR-AP-4	CCR-AP-4	CCR-AP-4
Sample Name	CCR-AP-4-20160610	CCR-AP-4-20160812	CCR-AP-4-20161028	CCR-AP-4-20161207	CCR-AP-4-20170208	CCR-AP-4-20170406	CCR-AP-4-20170608	CCR-AP-4-20170929	CCR-AP-4-20171117
Sample Date	06/10/2016	08/12/2016	10/28/2016	12/07/2016	02/08/2017	04/06/2017	06/08/2017	09/29/2017	11/17/2017
Lab Sample ID	180-55667-4	180-57631-4	180-60350-4	180-61530-4	180-63329-4	180-65041-6	180-67233-4	180-70838-8	180-72640-4
Water Level (ft amsl)	386.99	386.89	384.57	383.48	385.12	385.24	384.93	385.35	385.57
Monitoring Program	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Detection
Field Parameters									
Temperature (Deg C)	25.41	23.12	15.92	16.59	15.16	13.92	21.09	21.03	13.29
Turbidity, Field (FNU)	-	-	-	-	-	-	-	-	-
Dissolved Oxygen, Field (mg/L)	1.34	2.37	3.75	4.8	0.21	2.63	3.95	2.65	1.02
Conductivity, Field (mS/cm)	1.83585	1.971	1.86696	1.3787	1.8253	1.50947	1.75801	1.90655	1.89809
ORP, Field (mv)	-106.23	-129	-108.94	-115.5	-130.18	-16.37	-101.4	-166.25	-113.5
Turbidity, Field (NTU)	999.34	266.5	294.14	1.7824	242.85	1091	655.07	1016	419.08
pH, Field (su)	6.64	7.56	6.98	6.58	6.58	7.1	7.32	6.98	6.58
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	0.16	0.16 J+	0.18	0.16 J+	0.14 U	0.17	0.18 U	0.085	0.14 U
Calcium, Total	160	190	170 J-	160	180 J-	180 J+	190	170	180
Chloride (mg/L)	25	24	85 J+	70	49	48	46	41	40
Fluoride (mg/L)	0.29 J+	0.43	0.3	0.49	0.32 J+	0.36	0.46	0.35	0.35
Sulfate (mg/L)	20 J-	R	15 J+	3.9 J+	1 U	1 U	0.64 J	0.63 J	1.1 J-
pH (lab) (su)	6.95 J	7.3 J	6.7 J	7 J	6.9 J	6.7 J	6.7 J	6.8 J	7.1 J
Total Dissolved Solids (TDS) (mg/L)	1000	1000	890	880	900	960	1000	980	910
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	0.002 U	0.002 U	0.002 U	0.0004 J	0.002 U	0.002 U	0.002 U	0.00066 J	0.002 U
Arsenic, Total	0.036	0.065	0.05	0.045	0.086	0.086	0.086	0.081	0.083
Barium, Total	0.52	0.75	0.63	0.61	0.64	0.63	0.66	0.58	0.57
Beryllium, Total	0.00049 J	0.00033 J	0.00025 J	0.00046 J	0.00014 J	0.00015 J	0.00026 J	0.00017 J	0.00028 J
Cadmium, Total	0.00018 J	0.00018 J	0.001 U	0.00023 J	0.001 U	0.001 U	0.00014 J	0.00016 J	0.001 U
Chromium, Total	0.012	0.0081	0.0037	0.014	0.0026	0.0028	0.0066	0.0076	0.01
Cobalt, Total	0.0078	0.0071	0.0045 J	0.0086	0.0039	0.0045	0.0068	0.0055	0.0064
Lead, Total	0.0099	0.0063	0.0057 J	0.011	0.0018	0.0018 J+	0.0045	0.0048	0.0046
Lithium, Total	0.01 J	0.0096 J	0.014 J	0.0098 J	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Molybdenum, Total	0.0022 J	0.0025 J	0.0011 J	0.002 J	0.00093 J	0.00092 J	0.0014 J	0.0016 J	0.0022 J
Selenium, Total	0.0018 J	0.0016 J	0.0011 J	0.00098 J	0.005 U	0.005 UJ	0.005 U	0.005 U	0.005 U
Thallium, Total	0.000084 J	0.000061 J	0.00011 J	0.00015 J	0.000063 J	0.001 U	0.000061 J	0.001 U	0.00012 J
Mercury, Total	0.0002 U	0.0002 U	0.0004 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Radiological (pCi/L)									
Radium-226	1.07 J ± 0.261	1.53 ± 0.429	1.54 ± 0.683	2.11 ± 1.11	0.984 ± 0.383	0.789 ± 0.227	1.60 ± 0.408	1.26 ± 0.397	1.15 ± 0.266
Radium-226 & 228	1.49 ± 0.769	2.90 ± 1.49	2.40 ± 0.816	4.28 ± 1.74	2.01 ± 0.728	1.16 J ± 0.538	3.60 ± 0.914	R	R
Radium-228	0.417 U ± 0.723	1.37 U ± 1.43	0.864 ± 0.448	2.17 ± 1.34	1.03 ± 0.620	0.370 U ± 0.488	2.00 ± 0.818	R	R

ABBREVIATIONS AND NOTES:
- CCR: Coal Combustion Residuals
- CFR: Code of Federal Regulations
- ft amsl: feet above mean sea level
- MCL: Maximum Contaminant Level
- mg/L: milligram per liter
- mS/cm: milliSiemen per centimeter
- mv: millivolt
- NA: Not Applicable
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- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257.
https://www.epa.gov/coalash/coal-ash-rule

TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Downgradient								
Location Name	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5
Sample Name	CCR-AP-5-20160610	CCR-AP-5-20160812	CCR-AP-5-20161028	CCR-AP-5-20161207	CCR-AP-5-20170208	CCR-AP-5-20170407	CCR-AP-5-20170608	CCR-AP-5-20170928	CCR-AP-5-20171117
Sample Date	06/10/2016	08/12/2016	10/28/2016	12/07/2016	02/08/2017	04/07/2017	06/08/2017	09/28/2017	11/17/2017
Lab Sample ID	180-55667-5	180-57631-5	180-60350-5	180-61530-5	180-63329-5	180-65041-7	180-67233-5	180-70838-1	180-72640-5
Water Level (ft amsl)	383.83	382.15	377.81	378.14	383.3	383.12	382.28	380.86	382.01
Monitoring Program	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Detection
Field Parameters									
Temperature (Deg C)	**19.48**	**19.13**	**18.43**	**15.84**	**16.05**	**17.66**	**18.75**	**18.88**	**17**
Turbidity, Field (FNU)	-	-	-	-	-	-	-	**11.86**	-
Dissolved Oxygen, Field (mg/L)	**0.04**	**0.08**	**-0.02**	**0.25**	**0.07**	**0.05**	**0.08**	**0.08**	**0.09**
Conductivity, Field (mS/cm)	**4.89844**	**4.82**	**5.02113**	**3.9142**	**4.86306**	**4.22473**	**3.95584**	**4.19408**	**4.48884**
ORP, Field (mv)	**-82.1**	**-133**	**-247.07**	**-181.1**	**67.41**	**59.85**	**43.86**	**42.55**	**69.25**
Turbidity, Field (NTU)	**11.79**	**4.632**	**-3.91**	**2.44**	**0.62**	**-16.87**	**-1.13**	-	**1.94**
pH, Field (su)	**7**	**6.92**	**7.03**	**6.85**	**6.83**	**6.93**	**6.86**	**6.75**	**6.7**
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	**53**	**54**	**68**	**64**	**59**	**56**	**58**	**33**	**52**
Calcium, Total	**520**	**480**	**550 J-**	**570**	**580 J-**	**550 J+**	**510**	**470**	**510**
Chloride (mg/L)	**880**	**750**	**860 J+**	**860**	**780**	**880**	**560**	**640**	**770**
Fluoride (mg/L)	**0.58**	**0.99**	**1.1**	**1.3**	**0.98**	**0.96**	**1.1**	**0.76 J**	**1**
Sulfate (mg/L)	2.5 UJ	**1500**	**1600 J+**	**1700**	**1500**	**1900**	**1400**	**1400**	**1600 J-**
pH (lab) (su)	**7.09 J**	**7.4 J**	**7 J**	**7 J**	**7.2 J**	**7 J**	**7.1 J**	**7 J**	**7 J**
Total Dissolved Solids (TDS) (mg/L)	**4600**	**4400**	**4000**	**4200**	**4000**	**4200**	**4200**	**3300**	**3500**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	0.02 U	0.002 U	0.002 U	**0.000058 J**	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.01 U	**0.00059 J**	**0.00065 J**	**0.00073 J**	**0.0015**	**0.00039 J**	**0.00042 J**	**0.00084 J**	**0.00039 J**
Barium, Total	**0.032 J**	**0.03**	**0.034**	**0.036**	**0.046**	**0.034**	**0.036**	**0.041**	**0.038**
Beryllium, Total	0.01 U	0.001 U	0.001 U	**0.00096 J**	**0.00019 J**	**0.00058 J**	**0.00017 J**	**0.00047 J**	0.001 U
Cadmium, Total	0.01 U	**0.00016 J**	**0.00015 J**	0.001 U	**0.0012**	**0.0004 J**	**0.00037 J**	**0.00075 J**	**0.00035 J**
Chromium, Total	0.02 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Cobalt, Total	**0.0069**	**0.0063**	**0.0065 J**	**0.0061**	**0.007**	**0.0063**	**0.0053**	**0.0041**	**0.0046**
Lead, Total	0.01 U	0.001 U	0.001 UJ	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Lithium, Total	**0.14**	**0.13**	**0.15**	**0.13**	**0.15**	**0.15**	**0.11**	**0.099**	**0.12**
Molybdenum, Total	**0.38**	**0.37**	**0.41**	**0.39**	**0.39**	**0.33**	**0.3**	**0.21**	**0.24**
Selenium, Total	0.05 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 UJ	0.005 U	0.005 U	0.005 U
Thallium, Total	0.01 U	0.001 U	0.001 U	0.001 U	**0.000065 J**	0.001 U	0.001 U	**0.00016 J**	**0.00018 J**
Mercury, Total	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Radiological (pCi/L)									
Radium-226	**0.224 J ± 0.0858**	0.106 U ± 0.0753	0.449 U ± 0.338	0.0176 U ± 0.286	0.0782 U ± 0.217	**0.186 ± 0.0813**	**0.193 ± 0.0924**	**0.184 ± 0.0749**	**0.250 ± 0.0868**
Radium-226 & 228	**0.774 ± 0.313**	**0.629 ± 0.338**	**0.911 ± 0.486**	**0.732 J ± 0.524**	0.640 U ± 0.561	**0.396 J ± 0.241**	**1.21 ± 0.369**	R	**0.483 J+ ± 0.253**
Radium-228	**0.550 ± 0.300**	**0.523 ± 0.330**	0.462 U ± 0.350	**0.714 ± 0.438**	0.562 U ± 0.517	0.209 U ± 0.227	**1.01 ± 0.357**	R	0.234 U ± 0.238

ABBREVIATIONS AND NOTES:

- CCR: Coal Combustion Residuals
- CFR: Code of Federal Regulations
- ft amsl: feet above mean sea level
- MCL: Maximum Contaminant Level
- mg/L: milligram per liter
- mS/cm: milliSiemen per centimeter
- mv: millivolt
- NA: Not Applicable
- NTU: Nephelometric Turbidity Units
- pCi/L: picoCurie per liter
- su: standard units
- USEPA: United States Environmental Protection Agency

QUALIFIERS:

- J: value is estimated
- J+: value is estimated with a potentially high bias
- J-: value is estimated with a potentially low bias
- R: value is rejected
- U: Not detected value is the laboratory reporting limit

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Downgradient								
Location Name	CCR-AP-6	CCR-AP-6	CCR-AP-6	CCR-AP-6	CCR-AP-6	CCR-AP-6	CCR-AP-6	CCR-AP-6	CCR-AP-6
Sample Name	CCR-AP-6-20160610	CCR-AP-6-20160812	CCR-AP-6-20161028	CCR-AP-6-20161207	CCR-AP-6-20170208	CCR-AP-6-20170406	CCR-AP-6-20170607	CCR-AP-6-20170929	CCR-AP-6-20171117
Sample Date	06/10/2016	08/12/2016	10/28/2016	12/07/2016	02/08/2017	04/06/2017	06/07/2017	09/29/2017	11/17/2017
Lab Sample ID	180-55667-6	180-57631-6	180-60350-6	180-61530-6	180-63329-6	180-65041-8	180-67233-6	180-70838-9	180-72640-6
Water Level (ft amsl)	357.44	357.42	357.81	357.84	357.16	357.22	357.77	358.13	358.29
Monitoring Program	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Detection
Field Parameters									
Temperature (Deg C)	25.88	22.71	18.2	14.06	13.66	17.82	19.24	22.6	13.65
Turbidity, Field (FNU)	-	-	-	-	-	-	-	-	-
Dissolved Oxygen, Field (mg/L)	0.57	3.82	1.16	5.36	5.85	0.65	3.08	3.48	2
Conductivity, Field (mS/cm)	1.80952	1.894	1.45907	1.2681	1.79982	1.85853	1.69037	1.83685	1.78431
ORP, Field (mv)	-150.64	-113	-146.47	-215.4	-107.54	-104.62	-108.17	-241.24	-130.25
Turbidity, Field (NTU)	293.44	1073	1030	632.75	1329	397.33	1076	977.25	445.51
pH, Field (su)	6.88	7.56	7.28	7.31	7.19	7.17	7.35	7.44	7.07
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	1.1	0.83	0.74	0.79 J+	0.89 J+	2.2	1.3 J+	0.44	2.1 J+
Calcium, Total	180	190	190 J-	190	200 J-	210 J+	200	180	180
Chloride (mg/L)	40	39	38 J+	36	42	46	40	38	42
Fluoride (mg/L)	0.43	0.67	0.42	0.62	0.5	0.45	0.63	0.55	0.24
Sulfate (mg/L)	0.57 J-	R	0.98 J+	1 U	0.67 J	0.5 J	1.1	0.71 J	0.74 J-
pH (lab) (su)	7.35 J	7.8 J	7.2 J	7.3 J	7.4 J	7.2 J	7.3 J	7.3 J	7.6 J
Total Dissolved Solids (TDS) (mg/L)	1100	1100	1000	1000	1000	1100	1200	1100	1000
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	0.002 U	0.002 U	0.002 U	0.00048 J	0.00047 J	0.002 U	0.00059 J	0.0014 J	0.01 U
Arsenic, Total	0.04	0.059	0.06	0.067	0.11	0.11	0.096	0.089	0.081
Barium, Total	0.51	0.58	0.55	0.62	0.61	0.64	0.6	0.55	0.49
Beryllium, Total	0.001 U	0.00026 J	0.00011 J	0.00036 J	0.00025 J	0.00024 J	0.00042 J	0.00039 J	0.005 U
Cadmium, Total	0.001 U	0.00016 J	0.001 U	0.00029 J	0.00027 J	0.00019 J	0.00024 J	0.00052 J	0.00039 J
Chromium, Total	0.0031	0.0092	0.005	0.015	0.011	0.0098	0.014	0.02	0.014
Cobalt, Total	0.0042	0.0095	0.0075 J	0.01	0.009	0.0069	0.011	0.012	0.0087
Lead, Total	0.0021	0.0071	0.0035 J	0.01	0.0079	0.0074 J+	0.0096	0.014	0.011
Lithium, Total	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.011 J	0.05 U	0.25 U
Molybdenum, Total	0.02	0.018	0.021	0.024	0.03	0.024	0.026	0.033	0.027
Selenium, Total	0.001 J	0.0014 J	0.0015 J	0.0014 J	0.005 U	0.0018 J-	0.0014 J	0.0023 J	0.025 U
Thallium, Total	0.001 U	0.000047 J	0.001 U	0.0001 J	0.000063 J	0.001 U	0.00009 J	0.00013 J	0.005 U
Mercury, Total	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Radiological (pCi/L)									
Radium-226	0.652 J ± 0.142	1.32 ± 0.278	1.38 ± 0.686	-0.236 U ± 0.919	0.929 ± 0.371	0.730 ± 0.221	2.33 ± 0.648	0.815 ± 0.227	0.695 ± 0.171
Radium-226 & 228	1.20 ± 0.325	2.13 ± 0.776	2.05 J ± 0.868	1.58 U ± 1.80	1.68 J ± 0.690	1.19 J ± 0.490	5.93 ± 1.60	R	R
Radium-228	0.543 ± 0.293	0.811 U ± 0.725	0.663 U ± 0.532	1.58 U ± 1.55	0.755 U ± 0.581	0.455 U ± 0.438	3.61 ± 1.47	R	R

ABBREVIATIONS AND NOTES:
CCR: Coal Combustion Residuals
CFR: Code of Federal Regulations
ft amsl: feet above mean sea level
MCL: Maximum Contaminant Level
mg/L: milligram per liter
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mv: millivolt
NA: Not Applicable
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TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Downgradient								
Location Name	CCR-AP-8	CCR-AP-8	CCR-AP-8	CCR-AP-8	CCR-AP-8	CCR-AP-8	CCR-AP-8	CCR-AP-8	CCR-AP-8
Sample Name	CCR-AP8-20170309	CCR-AP-8-20170406	CCR-AP-8-20170426	CCR-AP-8-20170530	CCR-AP-8-20170607	CCR-AP-8-20170725	CCR-AP-8-20170815	CCR-AP-8-20170928	CCR-AP-8-20171117
Sample Date	03/09/2017	04/06/2017	04/26/2017	05/30/2017	06/07/2017	07/25/2017	08/15/2017	09/28/2017	11/17/2017
Lab Sample ID	180-64223-1	180-65041-1	180-65680-1	180-66910-1	180-67233-8	180-68557-1	180-69382-1	180-70838-10	180-72640-8
Water Level (ft amsl)	362.235	364.335	-	361.715	361.675	362.845	363.815	362.695	363.725
Monitoring Program	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Detection
Field Parameters									
Temperature (Deg C)	**19.68**	**14.06**	**23.49**	**24.86**	**20.32**	**24.02**	**27.23**	**19.71**	**14.18**
Turbidity, Field (FNU)	-	-	-	-	-	-	-	-	-
Dissolved Oxygen, Field (mg/L)	**3.19**	**2.37**	**3.52**	**0.3**	**2.73**	**2.33**	**0.89**	**2.22**	**2.99**
Conductivity, Field (mS/cm)	**2.39775**	**2.94999**	**2.50325**	**2.60564**	**2.35891**	**2.48464**	**2.48283**	**2.47995**	**2.47027**
ORP, Field (mv)	**-7.78**	**-90.85**	**-116.37**	**-115.14**	**-124.99**	**-66.59**	**-113.76**	**-159.16**	**-120.85**
Turbidity, Field (NTU)	**116.68**	**274.89**	**774.8**	**527.69**	**433.46**	**453.72**	**188.03**	**142.91**	**553**
pH, Field (su)	**6.14**	**7.09**	**6.95**	**6.86**	**7.26**	**7.9**	**6.43**	**6.78**	**6.92**
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	**0.037 J**	0.08 U	0.08 U	**0.034 J**	0.08 U	0.08 U	0.08 U	**0.025 J**	0.043 U
Calcium, Total	**300**	**320 J+**	**320**	**340**	**330**	**350**	**340**	**320**	**300**
Chloride (mg/L)	**21**	**19**	**18**	**17**	**13**	**17**	**16**	**17**	**16**
Fluoride (mg/L)	**0.13**	**0.35**	**0.28**	**0.24**	**0.21 J**	**0.24 J**	**0.26**	**0.34**	**0.4**
Sulfate (mg/L)	**37**	**16**	**1.6**	**6.2**	**4 J**	**3.8**	**5**	**2.3**	**1.9 J-**
pH (lab) (su)	**7.2 J**	**6.9 J**	**7 J**	**7.3 J**	**7 J**	**7 J**	**7.3 J**	**7 J**	**7 J**
Total Dissolved Solids (TDS) (mg/L)	**1400**	**1400**	**1400**	**1500**	**1500**	**1500**	**1400**	**1400**	**1300**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	**0.0018 J**	**0.00066 J**	**0.001 J**	**0.00082 J**	**0.0011 J**	0.002 U	**0.0014 J**	0.002 U	0.002 U
Arsenic, Total	**0.044**	**0.052**	**0.07**	**0.06**	**0.076**	**0.087**	**0.095**	**0.087**	**0.083**
Barium, Total	**0.57**	**0.59**	**0.59**	**0.58**	**0.6**	**0.67**	**0.64**	**0.56**	**0.53**
Beryllium, Total	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.0002 J**	**0.00039 J**	0.001 U	0.001 U
Cadmium, Total	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.00016 J**	0.001 U	0.001 U
Chromium, Total	**0.0012 J**	**0.0022**	**0.0019 J**	**0.0028**	R	**0.0041**	**0.012**	**0.0021 J+**	**0.0021**
Cobalt, Total	**0.015**	**0.012**	**0.011**	**0.011**	**0.011**	**0.012**	**0.017**	**0.0098**	**0.0082**
Lead, Total	**0.00058 J**	**0.0011 J+**	**0.00081 J**	**0.0022**	**0.001**	**0.0025**	**0.0076**	**0.0011**	**0.0011**
Lithium, Total	0.05 U	0.05 U	**0.014 J**	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U
Molybdenum, Total	**0.014**	**0.015**	**0.014**	**0.013**	**0.014**	**0.014**	**0.015**	**0.012**	**0.012**
Selenium, Total	0.005 U	**0.0017 J-**	**0.0015 J**	**0.0017 J**	**0.0017 J**	**0.0015 J**	**0.0022 J**	**0.002 J**	0.005 U
Thallium, Total	0.001 U	0.001 U	0.001 U	0.001 U	**0.000068 J**	**0.000058 J**	**0.00015 J**	0.001 U	**0.00029 J**
Mercury, Total	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Radiological (pCi/L)									
Radium-226	**0.893 ± 0.233**	**1.34 ± 0.310**	**0.883 ± 0.196**	**0.720 ± 0.162**	**0.721 J ± 0.211**	**0.704 ± 0.201**	**0.513 ± 0.143**	**0.529 ± 0.153**	**0.640 ± 0.164**
Radium-226 & 228	**1.96 J ± 1.04**	**2.01 ± 0.534**	**1.66 ± 0.421**	**1.18 ± 0.327**	**2.32 J ± 0.594**	**1.59 J ± 0.754**	**0.829 J ± 0.337**	R	R
Radium-228	1.07 U ± 1.02	**0.677 ± 0.435**	**0.778 ± 0.372**	**0.457 ± 0.284**	**1.60 J ± 0.556**	0.889 U ± 0.726	0.316 U ± 0.305	R	R

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TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Upgradient								
Location Name	CCR-AP-1R	CCR-AP-1R	CCR-AP-1R	CCR-AP-1R	CCR-AP-1R	CCR-AP-1R	CCR-AP-1R	CCR-AP-1R	CCR-AP-1R
Sample Name	CCR-AP-1-20160610	CCR-AP-1-20160812	CCR-AP-1-20161028	CCR-AP-1-20161207	CCR-AP-1-20170208	CCR-AP-1-20170406	CCR-AP-1-20170607	CCR-AP-1-20170928	CCR-AP-1 -20171117
Sample Date	06/10/2016	08/12/2016	10/28/2016	12/07/2016	02/08/2017	04/06/2017	06/07/2017	09/28/2017	11/17/2017
Lab Sample ID	180-55667-1	180-57631-1	180-60350-1	180-61530-1	180-63329-1	180-65041-3	180-67233-1	180-70838-5	180-72640-1
Water Level (ft amsl)	388.98	388.07	387.44	386.93	388.04	388.09	388.06	388.5	387.6
Monitoring Program	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Detection
Field Parameters									
Temperature (Deg C)	**21.31**	**25.58**	**20.76**	**8.43**	**10.31**	**14.42**	**19.36**	**18.61**	**13.03**
Turbidity, Field (FNU)	-	-	-	-	-	-	-	-	-
Dissolved Oxygen, Field (mg/L)	**1.28**	**0.13**	**0.6**	**11.68**	**8.29**	**3.13**	**3.2**	**1.01**	**8.88**
Conductivity, Field (mS/cm)	**1.12255**	**1.991**	**1.04547**	**1.0845**	**1.19011**	**1.55613**	**1.10803**	**1.20077**	**1.21515**
ORP, Field (mv)	**-148.68**	**-11.7**	**-171.8**	**-247.3**	**-60.52**	**15.79**	**90.06**	**-41.88**	**-14.37**
Turbidity, Field (NTU)	**1225**	**53.02**	**459.55**	**1053**	**1350**	**335.21**	**86.58**	**3.49**	**7.28**
pH, Field (su)	**7.38**	**7.87**	**7.85**	**8.12**	**8**	**8.01**	**8.33**	**7.46**	**7.72**
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	**0.51**	**0.54**	**0.65**	**0.68 J+**	**0.69 J+**	**0.62**	**0.72 J+**	**0.44**	**0.82 J+**
Calcium, Total	**53**	**51**	**50 J-**	**44**	**42 J-**	**55 J+**	**55**	**48**	**57**
Chloride (mg/L)	**19**	**18**	**19 J+**	**19**	**18**	**17**	**18**	**18**	**18**
Fluoride (mg/L)	**0.81**	**0.48**	**0.5**	**0.55**	**0.53**	**0.57**	**0.58**	**0.49**	**0.48**
Sulfate (mg/L)	**180 J-**	**180**	**110 J+**	**130**	**140**	**150**	**150**	**160**	**170 J-**
pH (lab) (su)	**7.74 J**	**8.1 J**	**7.6 J**	**7.7 J**	**7.5 J**	**7.8 J**	**7.7 J**	**7.7 J**	**7.9 J**
Total Dissolved Solids (TDS) (mg/L)	**740**	**760**	**740**	**710**	**750**	**730**	**840**	**770**	**770**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	0.002 U	0.002 U	0.002 U	**0.00072 J**	**0.00077 J**	**0.00055 J**	**0.00053 J**	**0.0025**	0.01 U
Arsenic, Total	**0.0045**	**0.0067**	**0.0024**	**0.0036**	**0.0068**	**0.012**	**0.008**	**0.0055**	**0.0075**
Barium, Total	**0.077**	**0.12**	**0.05**	**0.081**	**0.11**	**0.16**	**0.11**	**0.086**	**0.15**
Beryllium, Total	**0.00053 J**	**0.00074 J**	**0.00011 J**	**0.00049 J**	**0.00058 J**	**0.0014**	**0.00073 J**	**0.00035 J**	**0.0013 J**
Cadmium, Total	0.001 U	0.001 U	0.001 U	0.001 U	**0.000081 J**	**0.00018 J**	0.001 U	0.001 U	0.005 U
Chromium, Total	**0.011**	**0.02**	**0.0019 J**	**0.0092**	**0.012**	**0.03**	**0.015**	**0.01**	**0.021**
Cobalt, Total	**0.0081**	**0.014**	**0.0015 J**	**0.005**	**0.0083**	**0.017**	**0.0088**	**0.0059**	**0.013**
Lead, Total	**0.0074**	**0.013**	**0.0011 J**	**0.0057**	**0.0083**	**0.02 J+**	**0.0093**	**0.0068**	**0.014**
Lithium, Total	**0.045 J**	**0.053**	**0.035 J**	**0.035 J**	**0.043 J**	**0.063**	**0.049 J**	**0.036 J**	**0.059 J**
Molybdenum, Total	**0.015**	**0.013**	**0.006**	**0.0047 J**	**0.0073**	**0.0067**	**0.0073**	**0.008**	**0.013 J**
Selenium, Total	**0.00071 J**	**0.0014 J**	0.005 U	**0.00045 J**	0.005 U	**0.0014 J-**	0.005 U	0.005 U	0.025 U
Thallium, Total	**0.000082 J**	**0.00012 J**	0.001 U	**0.000079 J**	**0.00033 J**	0.001 U	**0.00012 J**	**0.000088 J**	**0.0014 J**
Mercury, Total	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Radiological (pCi/L)									
Radium-226	**0.607 J ± 0.204**	**3.13 ± 0.594**	0.353 U ± 0.558	1.75 U ± 1.31	**2.99 ± 0.678**	**2.28 ± 0.580**	**1.74 ± 0.489**	**1.94 ± 0.553**	**3.33 ± 0.689**
Radium-226 & 228	0.950 U ± 0.690	**6.32 ± 1.51**	0.862 U ± 0.753	2.09 U ± 1.98	**6.56 ± 1.18**	**6.73 J ± 1.47**	**5.00 ± 1.19**	**6.46 ± 1.53**	R
Radium-228	0.344 U ± 0.659	**3.20 ± 1.39**	0.509 U ± 0.505	0.340 U ± 1.48	**3.58 ± 0.962**	**4.45 ± 1.35**	**3.25 ± 1.09**	**4.52 ± 1.43**	R

ABBREVIATIONS AND NOTES:
CCR: Coal Combustion Residuals
CFR: Code of Federal Regulations
ft amsl: feet above mean sea level
MCL: Maximum Contaminant Level
mg/L: milligram per liter
mS/cm: milliSiemen per centimeter
mv: millivolt
NA: Not Applicable
NTU: Nephelometric Turbidity Units
pCi/L: picoCurie per liter
su: standard units
USEPA: United States Environmental Protection Agency

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J+: value is estimated with a potentially high bias
J-: value is estimated with a potentially low bias
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- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257.
https://www.epa.gov/coalash/coal-ash-rule

TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Upgradient								
Location Name	CCR-AP-7	CCR-AP-7	CCR-AP-7	CCR-AP-7	CCR-AP-7	CCR-AP-7	CCR-AP-7	CCR-AP-7	CCR-AP-7
Sample Name	CCR-AP-7-20160610	CCR-AP-7-20160812	CCR-AP-7-20161028	CCR-AP-7-20161207	CCR-AP-7-20170208	CCR-AP-7-20170406	CCR-AP-7-20170607	CCR-AP-7-20170928	CCR-AP-7-20171117
Sample Date	06/10/2016	08/12/2016	10/28/2016	12/07/2016	02/08/2017	04/06/2017	06/07/2017	09/28/2017	11/17/2017
Lab Sample ID	180-55667-7	180-57631-7	180-60350-7	180-61530-7	180-63329-7	180-65041-9	180-67233-7	180-70838-3	180-72640-7
Water Level (ft amsl)	427.57	421.87	418.13	420.84	428.16	429.3	422.65	417.49	419.55
Monitoring Program	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Detection
Field Parameters									
Temperature (Deg C)	**20.27**	**19.2**	**22.01**	**15.31**	**13.89**	**16.15**	**16.62**	**17.93**	**14.47**
Turbidity, Field (FNU)	-	-	-	-	-	-	-	**11.09**	-
Dissolved Oxygen, Field (mg/L)	**0.21**	**0.15**	**0.69**	**0.23**	**-0.02**	**-0.02**	**0.09**	**0.13**	**0.21**
Conductivity, Field (mS/cm)	**0.96343**	**0.9769**	**0.90788**	**0.76817**	**1.00796**	**1.578**	**0.98246**	**0.97415**	**0.97231**
ORP, Field (mv)	**-105.35**	**-152**	**-141.57**	**-146.4**	**-80.23**	**-115.03**	**-143.84**	**-153.3**	**-103.98**
Turbidity, Field (NTU)	**27.02**	**18.9**	**207.68**	**370.05**	**385.27**	**519.28**	**193.1**	-	**3.04**
pH, Field (su)	**7.05**	**7.13**	**7.77**	**7.34**	**7.21**	**7.24**	**7.18**	**7.11**	**7.02**
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	**0.034 J+**	0.034 U	**0.02 J+**	0.071 U	0.034 U	0.08 U	0.15 U	**0.056 J**	0.091 U
Calcium, Total	**86**	**88**	**120 J-**	**99**	**150 J-**	**110 J+**	**100**	**94**	**96**
Chloride (mg/L)	**31**	**26**	**25 J+**	**26**	**25**	**27**	**28**	**29**	**31**
Fluoride (mg/L)	R	**0.24**	**0.25**	**0.37 J+**	**0.28 J+**	**0.29**	**0.34**	**0.19**	**0.25**
Sulfate (mg/L)	**93 J-**	**73**	**66 J+**	**96**	**110**	**110**	**100**	**82**	**77 J-**
pH (lab) (su)	**7.37 J**	**7.9 J**	**7.1 J**	**7.4 J**	**7.4 J**	**7.3 J**	**7.3 J**	**7.3 J**	**7.2 J**
Total Dissolved Solids (TDS) (mg/L)	**590**	**580**	**530**	**620**	**630**	**640**	**620**	**570**	**550**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	0.002 U	0.002 U	0.002 U	**0.00016 J**	**0.00062 J**	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic, Total	**0.0025**	**0.0048**	**0.0084**	**0.0083**	**0.018**	**0.008**	**0.0075**	**0.0058**	**0.0034**
Barium, Total	**0.1**	**0.12**	**0.16**	**0.14**	**0.19**	**0.15**	**0.15**	**0.12**	**0.11**
Beryllium, Total	0.001 U	0.001 U	**0.00017 J**	**0.00012 J**	**0.00075 J**	**0.00022 J**	**0.00015 J**	0.001 U	0.001 U
Cadmium, Total	0.001 U	0.001 U	0.001 U	0.001 U	**0.00032 J**	**0.00014 J**	0.001 U	0.001 U	0.001 U
Chromium, Total	**0.00048 J**	**0.00047 J**	**0.0026**	**0.0039**	**0.019**	**0.0048**	**0.0039 J+**	0.002 U	0.002 U
Cobalt, Total	**0.0012**	**0.0023**	**0.0053 J**	**0.0037**	**0.015**	**0.0054**	**0.0032**	**0.00054**	**0.0003 J**
Lead, Total	**0.00062 J**	**0.00099 J**	**0.0082 J**	**0.0036**	**0.02**	**0.0087 J+**	**0.0041**	0.001 U	0.001 U
Lithium, Total	**0.01 J**	**0.011 J**	**0.02 J**	**0.012 J**	**0.039 J**	**0.019 J**	**0.019 J**	**0.01 J**	**0.012 J**
Molybdenum, Total	**0.0082**	**0.0054**	**0.0044 J**	**0.0088**	**0.013**	**0.0058**	**0.0069**	**0.0036 J**	**0.0028 J**
Selenium, Total	**0.00035 J**	0.005 U	**0.00073 J**	0.005 U	0.005 U	0.005 UJ	0.005 U	0.005 U	0.005 U
Thallium, Total	0.001 U	0.001 U	**0.00008 J**	**0.000066 J**	**0.00061 J**	0.001 U	**0.000088 J**	0.001 U	0.001 U
Mercury, Total	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Radiological (pCi/L)									
Radium-226	**0.330 J ± 0.0973**	**0.390 ± 0.118**	**1.28 ± 0.664**	0.439 U ± 0.399	**0.744 ± 0.220**	**0.719 ± 0.182**	**0.398 ± 0.129**	**0.308 ± 0.0950**	**0.312 ± 0.0954**
Radium-226 & 228	**0.496 ± 0.284**	**1.02 J ± 0.363**	**1.72 J ± 0.792**	**0.997 ± 0.602**	**1.11 J ± 0.335**	**1.55 ± 0.464**	**1.29 ± 0.433**	R	R
Radium-228	0.166 U ± 0.267	**0.625 J ± 0.344**	0.434 U ± 0.433	0.558 U ± 0.451	0.365 U ± 0.252	**0.830 ± 0.427**	**0.895 ± 0.413**	R	R

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TABLE II
SUMMARY OF ANALYTICAL RESULTS
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Upgradient								
Location Name	CCR-AP-9	CCR-AP-9	CCR-AP-9	CCR-AP-9	CCR-AP-9	CCR-AP-9	CCR-AP-9	CCR-AP-9	CCR-AP-9
Sample Name	CCR-AP9-20170309	CCR-AP-9-20170407	CCR-AP-9-20170426	CCR-AP-9-20170530	CCR-AP-9-20170608	CCR-AP-9-20170725	CCR-AP-9-20170815	CCR-AP-9-20170928	CCR-AP-9-20171117
Sample Date	03/09/2017	04/07/2017	04/26/2017	05/30/2017	06/08/2017	07/25/2017	08/15/2017	09/28/2017	11/17/2017
Lab Sample ID	180-64223-2	180-65041-2	180-65680-2	180-66910-2	180-67233-9	180-68557-2	180-69382-2	180-70838-4	180-72640-9
Water Level (ft amsl)	386.205	387.795	-	387.155	386.475	384.785	384.755	384.775	385.425
Monitoring Program	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Detection
Field Parameters									
Temperature (Deg C)	22.55	14.76	21.56	19.42	19.39	15.07	22.98	17.42	13.11
Turbidity, Field (FNU)	-	-	-	-	-	-	-	-	-
Dissolved Oxygen, Field (mg/L)	3.72	4.25	4.36	3.16	2.56	0.99	3.39	3.76	2.38
Conductivity, Field (mS/cm)	0.00137	1.2589	0.8002	0.97237	0.33375	0.00135	0.99112	1.00763	1.04212
ORP, Field (mv)	-33.4	-38	-4.1	72.93	15.83	107.35	66.57	-25.8	-38.27
Turbidity, Field (NTU)	2810	1444	2275	1494	1873	1663	2320	2008	1760
pH, Field (su)	7.61	8.25	7.38	6.09	9.11	7.78	7.73	7.44	7.31
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	0.2	0.23	0.26 J+	0.26	0.29 U	0.25	0.22	0.29	0.34 U
Calcium, Total	92	110 J+	110	120	120	130	130	110	130
Chloride (mg/L)	23	21	21	19	20	19	18	17	16
Fluoride (mg/L)	0.14	0.36	0.35	0.33	0.42	0.3	0.33	0.3	0.36
Sulfate (mg/L)	130	120	120	110	110	90	110	120	120 J-
pH (lab) (su)	7.5 J	7.4 J	7.5 J	7.7 J	7.6 J	7.4 J	7.5 J	7.5 J	7.4 J
Total Dissolved Solids (TDS) (mg/L)	550	610	590	600	600	650	600	620	620
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	0.0044	0.0014 J	0.0012 J	0.0011 J	0.0014 J	0.002 U	0.00078 J	0.002 U	0.0079 J+
Arsenic, Total	0.0031	0.006	0.008	0.01	0.0077	0.01	0.0087	0.0058	0.0088
Barium, Total	0.13	0.23	0.23	0.27	0.21	0.28	0.24	0.21	0.29
Beryllium, Total	0.00017 J	0.00053 J	0.00066 J	0.00092 J	0.00047 J	0.0011	0.00073 J	0.00017 J	0.00095 J
Cadmium, Total	0.000079 J	0.000095 J	0.00011 J	0.00015 J	0.00011 J	0.00022 J	0.00014 J	0.001 U	0.005 U
Chromium, Total	0.0042	0.0088	0.012	0.014	0.0088	0.02	0.013	0.0067	0.019
Cobalt, Total	0.0062	0.012	0.013	0.013	0.0096	0.014	0.016	0.0072	0.015
Lead, Total	0.0025	0.0073 J+	0.0069	0.012	0.0056	0.011	0.0098	0.0033	0.0098
Lithium, Total	0.03 J	0.033 J	0.04 J	0.04 J	0.034 J	0.048 J	0.036 J	0.029 J	0.05 J
Molybdenum, Total	0.011	0.0097	0.0071	0.0065	0.0059	0.0059	0.0027 J	0.0043 J	0.0069 J
Selenium, Total	0.0058	0.005 UJ	0.005 U	0.005 U	0.005 U	0.005 U	0.0014 J	0.005 U	0.025 U
Thallium, Total	0.001 U	0.001 U	0.000098 J	0.00018 J	0.0001 J	0.00016 J	0.00011 J	0.001 U	0.00062 J
Mercury, Total	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Radiological (pCi/L)									
Radium-226	R	1.62 ± 0.470	1.91 ± 0.393	0.614 ± 0.173	1.43 ± 0.332	0.962 ± 0.286	1.68 ± 0.304	2.05 ± 0.533	1.38 ± 0.300
Radium-226 & 228	0.934 UJ ± 0.938	3.23 J ± 1.10	4.02 ± 0.905	1.23 J ± 0.447	3.49 ± 0.747	1.61 ± 0.510	R	3.52 J+ ± 1.13	R
Radium-228	0.401 U ± 0.915	1.61 ± 0.989	2.11 ± 0.815	0.619 U ± 0.412	2.06 ± 0.670	0.644 ± 0.422	R	1.47 U ± 0.995	R

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TABLE II
SUMMARY OF GROUNDWATER QUALITY DATA
EAST ASH POND - JUNE THROUGH AUGUST 2018
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA
FILE NO. 129420

Location Group	Action Level	Upgradient			
Location Name	Maximum	CCR-AP-1R	CCR-AP-1R	CCR-AP-7	CCR-AP-7
Sample Name	Contaminant	CCR-AP-1-20180611	CCR-AP-1-20180828	CCR-AP-7-20180611	CCR-AP-7-20180828
Sample Date	Level/Regional	06/11/2018	08/28/2018	06/11/2018	08/28/2018
Lab Sample ID	Screening Level	180-78672-1	180-81363-1	180-78672-7	180-81363-7
Detection Monitoring - EPA Appendix III Constituents (mg/L)					
Boron, Total	NA	-	**0.61 J**	-	0.08 U
Calcium, Total	NA	-	**47**	-	**100**
Chloride	NA	-	**11**	-	**27**
Fluoride	4	**0.47**	**0.47**	**0.31**	**0.31**
Sulfate (mg/L)	NA	-	**150**	-	**70**
Total Dissolved Solids (TDS)	NA	-	**820**	-	**580**
pH (lab) (SU)	NA	-	**7.8 J**	-	**7.5 J**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)					
Antimony, Total	0.006	0.02 U	0.02 U	0.002 U	0.002 U
Arsenic, Total	0.01	**0.029**	**0.023**	**0.0071**	**0.0064**
Barium, Total	2	**0.55**	**0.47**	**0.14**	**0.14**
Beryllium, Total	0.004	**0.0056 J**	**0.0033 J**	0.001 U	**0.000067 J**
Cadmium, Total	0.005	0.01 U	0.01 U	0.001 U	0.001 U
Chromium, Total	0.1	**0.12**	**0.13**	0.0014 U	**0.0061 J+**
Cobalt, Total	0.006	**0.047**	**0.036**	**0.00065**	**0.0014**
Fluoride	4	**0.47**	**0.47**	**0.31**	**0.31**
Lead, Total	0.015	**0.063**	**0.049**	**0.00041 J**	**0.0014**
Lithium, Total	0.04	**0.17**	**0.13**	**0.011**	**0.013**
Mercury, Total	0.002	0.0002 U	-	0.0002 U	-
Molybdenum, Total	0.1	**0.01 J**	**0.0077 J**	**0.0025 J**	**0.0026 J**
Selenium, Total	0.05	0.05 U	0.05 U	0.005 U	0.005 U
Thallium, Total	0.002	**0.001 J**	**0.00094 J**	0.001 U	0.001 U
Radiological (pCi/L)					
Radium-226	NA	**2.01 ± 0.674**	**2.42 ± 0.633**	**0.480 ± 0.216**	R
Radium-228	NA	**2.14 ± 0.626**	**2.65 ± 1.05**	0.0986 U ± 0.257	0.307 U ± 0.231
Radium-226 & 228	5	**4.15 ± 0.92**	**5.07 ± 1.23**	**0.579 J ± 0.336**	R

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Results in **bold** are detected.

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TABLE II
SUMMARY OF GROUNDWATER QUALITY DATA
EAST ASH POND - JUNE THROUGH AUGUST 2018
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA
FILE NO. 129420

Location Group	Action Level	Downgradient						
Location Name	Maximum	CCR-AP-2	CCR-AP-2	CCR-AP-3	CCR-AP-3	CCR-AP-4	CCR-AP-4	CCR-AP-5
Sample Name	Contaminant	CCR-AP-2-20180611	CCR-AP-2-20180828	CCR-AP-3-20180611	CCR-AP-3-20180828	CCR-AP-4-20180611	CCR-AP-4-20180828	CCR-AP-5-20180611
Sample Date	Level/Regional	06/11/2018	08/28/2018	06/11/2018	08/28/2018	06/11/2018	08/28/2018	06/11/2018
Lab Sample ID	Screening Level	180-78672-2	180-81363-2	180-78672-3	180-81363-3	180-78672-4	180-81363-4	180-78672-5
Detection Monitoring - EPA Appendix III Constituents (mg/L)								
Boron, Total	NA	-	**9.6**	-	**0.14**	-	**0.1**	-
Calcium, Total	NA	-	**220**	-	**180**	-	**190**	-
Chloride	NA	-	**150**	-	**12**	-	**16**	-
Fluoride	4	**0.28**	**0.25**	**0.56**	**0.33**	**0.41**	**0.29**	**1.4**
Sulfate (mg/L)	NA	-	**510**	-	**1 U**	-	**2.6**	-
Total Dissolved Solids (TDS)	NA	-	**1500**	-	**1000**	-	**950**	-
pH (lab) (SU)	NA	-	**6.9 J**	-	**7.3 J**	-	**6.8 J**	-
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)								
Antimony, Total	0.006	0.002 U	0.02 U	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.01	**0.013**	**0.021**	**0.08**	**0.071**	**0.027**	**0.11**	R
Barium, Total	2	**0.27**	**0.52**	**0.47**	**0.43**	**0.45**	**0.78**	**0.068**
Beryllium, Total	0.004	**0.0021**	**0.002 J**	0.001 U	0.001 U	0.001 U	**0.00084 J**	0.001 U
Cadmium, Total	0.005	**0.00089 J**	0.01 U	0.001 U	0.001 U	0.001 U	**0.00048 J**	**0.00057 J**
Chromium, Total	0.1	**0.042**	**0.082**	**0.0041 J+**	**0.0041 J+**	R	**0.028**	0.0014 U
Cobalt, Total	0.006	**0.023**	**0.029**	**0.0052**	**0.0046**	**0.002**	**0.013**	**0.0028**
Fluoride	4	**0.28**	**0.25**	**0.56**	**0.33**	**0.41**	**0.29**	**1.4**
Lead, Total	0.015	**0.03**	**0.035**	**0.00092 J**	**0.00078 J**	**0.00052 J**	**0.021**	**0.000099 J**
Lithium, Total	0.04	**0.033**	**0.057**	0.005 U	0.005 U	**0.0029 J**	**0.019**	**0.11**
Mercury, Total	0.002	0.0002 U	-	0.0002 U	-	0.0002 U	-	0.0002 U
Molybdenum, Total	0.1	**0.003 J**	**0.0056 J**	**0.0099**	**0.0096**	**0.0012 J**	**0.0033 J**	**0.39**
Selenium, Total	0.05	**0.0026 J**	0.05 U	**0.0023 J**	**0.0021 J**	**0.0009 J**	**0.0016 J**	0.005 U
Thallium, Total	0.002	**0.00048 J**	**0.00099 J**	0.001 U	0.001 U	0.001 U	**0.00026 J**	0.001 U
Radiological (pCi/L)								
Radium-226	NA	**0.597 ± 0.32**	R	**0.475 ± 0.329**	R	**0.830 ± 0.366**	**2.47 ± 0.635**	**0.261 ± 0.167**
Radium-228	NA	0.294 U ± 0.337	**0.880 ± 0.51**	0.292 U ± 0.375	**0.946 ± 0.416**	0.458 U ± 0.313	1.06 U ± 0.934	0.213 U ± 0.216
Radium-226 & 228	5	**0.891 J ± 0.465**	R	**0.768 J ± 0.499**	**1.70 J+ ± 0.463**	**1.29 J ± 0.482**	**3.53 J ± 1.13**	**0.474 J ± 0.273**

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TABLE II
SUMMARY OF GROUNDWATER QUALITY DATA
EAST ASH POND - JUNE THROUGH AUGUST 2018
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA
FILE NO. 129420

Location Group	Action Level	Downgradient						
Location Name	Maximum	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-6	CCR-AP-6	CCR-AP-8	CCR-AP-8
Sample Name	Contaminant	IND DUPLICATE-201806	CCR-AP-5-20180828	BLIND DUP-20180828	CCR-AP-6-20180611	CCR-AP-6-20180828	CCR-AP-8-20180611	CCR-AP-8-20180828
Sample Date	Level/Regional	06/11/2018	08/28/2018	08/28/2018	06/11/2018	08/28/2018	06/11/2018	08/28/2018
Lab Sample ID	Screening Level	180-78672-10	180-81363-5	180-81363-10	180-78672-6	180-81363-6	180-78672-8	180-81363-8
Detection Monitoring - EPA Appendix III Constituents (mg/L)								
Boron, Total	NA	-	**41**	**42**	-	**0.51**	-	0.08 U
Calcium, Total	NA	-	**320**	**340**	-	**190**	-	**280**
Chloride	NA	-	**340**	**350**	-	**19**	-	**6**
Fluoride	4	**1.5**	**1.3**	**1.3**	**0.6**	**0.42**	**0.41**	**0.21**
Sulfate (mg/L)	NA	-	**1200**	**1200**	-	**1.1**	-	**1.3**
Total Dissolved Solids (TDS)	NA	-	**2700**	**2700**	-	**1000**	-	**1300**
pH (lab) (SU)	NA	-	**7.2 J**	**7.2 J**	-	**7.4 J**	-	**7 J**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)								
Antimony, Total	0.006	0.002 U	0.002 U	0.002 U	**0.0012 J**	0.002 U	0.002 U	0.002 U
Arsenic, Total	0.01	R	0.001 U	**0.00082 J**	**0.12**	**0.1**	**0.11**	**0.096**
Barium, Total	2	**0.073**	**0.033**	**0.034**	**0.69**	**0.64**	**0.68**	**0.58**
Beryllium, Total	0.004	0.001 U	0.001 U	0.001 U	**0.00065 J**	**0.00046 J**	**0.00022 J**	**0.00016 J**
Cadmium, Total	0.005	**0.0006 J**	**0.00024 J**	**0.00027 J**	**0.00051 J**	**0.0005 J**	0.001 U	0.001 U
Chromium, Total	0.1	R	0.002 U	0.0033 U	**0.029**	**0.031**	**0.0069 J+**	**0.0068 J+**
Cobalt, Total	0.006	**0.0033**	**0.0028**	**0.0036**	**0.014**	**0.013**	**0.0086**	**0.0077**
Fluoride	4	**1.5**	**1.3**	**1.3**	**0.6**	**0.42**	**0.41**	**0.21**
Lead, Total	0.015	**0.000096 J**	0.001 U	0.001 U	**0.02**	**0.02**	**0.0033**	**0.0021**
Lithium, Total	0.04	**0.096**	**0.094**	**0.098**	**0.016**	**0.014**	**0.0057**	**0.0052**
Mercury, Total	0.002	0.0002 U	-	-	0.0002 U	-	0.0002 U	-
Molybdenum, Total	0.1	**0.42**	**0.37**	**0.38**	**0.033**	**0.031**	**0.013**	**0.012**
Selenium, Total	0.05	0.005 U	0.005 U	0.005 U	**0.0023 J**	**0.0019 J**	**0.0021 J**	**0.0018 J**
Thallium, Total	0.002	**0.000076 J**	0.001 U	0.001 U	**0.00022 J**	**0.0002 J**	**0.000083 J**	0.001 U
Radiological (pCi/L)								
Radium-226	NA	**0.231 ± 0.168**	R	R	**1.15 ± 0.384**	**1.71 J ± 0.551**	**0.544 ± 0.277**	R
Radium-228	NA	**0.605 ± 0.274**	0.252 U ± 0.311	0.130 U ± 0.253	**1.12 ± 0.415**	0.929 U ± 1.02	**0.502 ± 0.319**	0.367 U ± 0.309
Radium-226 & 228	5	**0.836 ± 0.321**	R	R	**2.27 ± 0.565**	**2.64 J ± 1.16**	**1.05 ± 0.422**	R

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TABLE II
SUMMARY OF GROUNDWATER QUALITY DATA
EAST ASH POND - MAY THROUGH OCTOBER 2019
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Action Level	Background					
Location Name		CCR-AP-7	CCR-AP-7	CCR-AP-1R	CCR-AP-1R	CCR-AP-9	CCR-AP-9
Sample Name	Maximum	CCR-AP-7-20190528	CCR-AP-7-20191023	CCR-AP-1R-20190528	CCR-AP-1R-20191023	CCR-AP-9-20190528	CCR-AP-9-20191022
Sample Date	Contaminant Level	05/28/2019	10/23/2019	05/28/2019	10/23/2019	05/28/2019	10/22/2019
Lab Sample ID		180-90609-7	180-97809-16	180-90609-1	180-97809-1	180-90609-9	180-97809-11
Detection Monitoring - EPA Appendix III Constituents (mg/L)							
Boron, Total	NA	**0.28 J**	0.08 U	**0.72 J-**	**0.43**	**0.41 J**	**0.36 J**
Calcium, Total	NA	**100**	**110**	**67**	**70**	**130**	**130**
Chloride	NA	**28**	**27**	**17**	**16**	**12**	**9.7**
Fluoride	4	**0.27 J+**	**0.14**	**0.57 J+**	**0.34**	**0.33 J+**	**0.21**
Sulfate	NA	**82**	**65**	**190**	**180**	**100**	**120**
Total Dissolved Solids (TDS)	NA	**590**	**530**	**890**	**300**	**650**	**600**
pH (lab) (SU)	NA	**7.5 J**	**7.4 HF**	**7.8 J**	**7.8 HF**	**7.5 J**	**7.6 HF**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)							
Antimony, Total	0.006	0.002 U	0.002 U	**0.00057 J**	**0.0019 J**	**0.00061 J**	0.01 U
Arsenic, Total	0.01	**0.0037**	**0.0075**	**0.038**	**0.037**	**0.0078**	**0.013**
Barium, Total	2	**0.13**	**0.15**	**0.38**	**0.59**	**0.29**	**0.35**
Beryllium, Total	0.004	0.001 U	0.001 U	**0.005**	**0.0066**	**0.00066 J**	**0.0011 J**
Cadmium, Total	0.005	0.001 U	0.001 U	**0.00052 J**	**0.00087 J**	**0.00014 J**	0.005 U
Chromium, Total	0.1	0.002 U	**0.0018 J**	**0.11**	**0.16**	**0.016 J+**	**0.033**
Cobalt, Total	0.006	**0.00047 J**	**0.001**	**0.075**	**0.081**	**0.012**	**0.017**
Fluoride	4	**0.27 J+**	**0.14**	**0.57 J+**	**0.34**	**0.33 J+**	**0.21**
Lead, Total	0.015	0.001 U	**0.0014**	**0.076**	**0.094**	**0.01**	**0.017**
Lithium, Total	0.04	**0.011**	**0.02**	**0.16**	**0.23**	**0.041**	**0.072**
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.002 J**	**0.0017 J**	**0.01**	**0.012 J**	**0.0038 J**	**0.0049 J**
Selenium, Total	0.05	0.005 U	0.005 U	0.005 U	**0.012 J**	0.005 U	**0.013 J**
Thallium, Total	0.002	0.001 U	0.001 U	**0.00074 J**	**0.0014 J**	**0.00016 J**	0.005 U
Radiological (pCi/L)							
Radium-226	NA	**0.423 ± 0.123**	**0.194 ± 0.097**	**0.564 ± 0.216**	**0.561 ± 0.237**	**1.02 ± 0.252**	**1.67 ± 0.375**
Radium-228	NA	0.112 U ± 0.31	**1.02 ± 0.324**	**1.91 ± 1.12**	**1.37 ± 0.665**	**1.30 ± 0.699**	**1.47 ± 0.625**
Radium-226 & 228	5	**0.535 J ± 0.334**	**1.21 ± 0.338**	**2.47 ± 1.14**	**1.93 ± 0.706**	**2.32 ± 0.743**	**3.13 ± 0.729**
Field Parameters							
Temperature (Deg C)	NA	**18.68**	**18.44**	**28.08**	**20.79**	**26.01**	**16.23**
Dissolved Oxygen, Field (mg/L)	NA	**0.03**	**0.18**	**4.51**	**2.01**	**3.75**	**7.72**
Conductivity, Field (mS/cm)	NA	**0.90624**	**0.97501**	**1.1438**	**1.273**	**0.91846**	**0.92719**
ORP, Field (mv)	NA	**-131.2**	**-111.5**	**79.4**	**-48.7**	**-32.9**	**-8.3**
Turbidity, Field (NTU)	NA	**1.97**	**21.59**	**3716**	**2013**	**2572**	**1547**
pH, Field (SU)	NA	**7.42**	**7.01**	**7.82**	**7.48**	**7.56**	**7.51**

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TABLE II
SUMMARY OF GROUNDWATER QUALITY DATA
EAST ASH POND - MAY THROUGH OCTOBER 2019
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Action Level	Downgradient								
Location Name		CCR-AP-10	CCR-AP-11	CCR-AP-11	CCR-AP-2	CCR-AP-2	CCR-AP-3	CCR-AP-3	CCR-AP-4	CCR-AP-4
Sample Name	Maximum	CCR-AP-10-20191024	CCR-AP-11-20190612	CCR-AP-11-20191023	CCR-AP-2-20190528	CCR-AP-2-20191022	CCR-AP-3-20190528	CCR-AP-3-20191022	CCR-AP-4-20190528	CCR-AP-4-20191022
Sample Date	Contaminant Level	10/24/2019	06/13/2019	10/23/2019	05/28/2019	10/22/2019	05/28/2019	10/22/2019	05/28/2019	10/22/2019
Lab Sample ID		180-97809-12	180-91361-4 1906573-5	180-97809-13	180-90609-2	180-97809-2	180-90609-3	180-97809-3	180-90609-4	180-97809-4
Detection Monitoring - EPA Appendix III Constituents (mg/L)										
Boron, Total	NA	**1.3**	**0.22 J+**	**0.21**	**6.8 J-**	**5.3**	**0.24 J**	**0.097**	**0.13 J**	0.4 U
Calcium, Total	NA	**82**	**110**	**94**	**190**	**220**	**190**	**190**	**180**	**180**
Chloride	NA	**22**	**20**	**15**	**160**	**120**	**25**	**23**	**30**	**26**
Fluoride	4	**0.49**	**0.32**	**0.3**	**0.4 J+**	**0.51**	**0.53 J+**	**0.39**	**0.37 J+**	**0.083 J**
Sulfate	NA	**4.5**	**310**	**330**	**490**	**310**	**0.5 J**	**0.91 J**	**2.8**	**4.8**
Total Dissolved Solids (TDS)	NA	**1000**	**870**	**680**	**1300**	**440**	**1000**	**990**	**940**	**910**
pH (lab) (SU)	NA	**7.5 HF**	**6.5 J**	**6.7 HF**	**7 J**	**6.8 HF**	**7.3 J**	**7.2 HF**	**6.8 J**	**6.8 HF**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)										
Antimony, Total	0.006	**0.00052 J**	0.002 U	0.002 U	**0.0011 J**	0.01 U	0.002 U	0.002 U	0.002 U	0.01 U
Arsenic, Total	0.01	**0.013**	**0.047**	**0.013**	**0.032**	**0.02**	**0.077**	**0.069**	**0.11**	**0.32**
Barium, Total	2	**0.17**	**0.34**	**0.12**	**0.26**	**0.28**	**0.44**	**0.48**	**0.66**	**1.3**
Beryllium, Total	0.004	0.001 U	**0.00017 J**	0.001 U	**0.0021**	**0.0019 J**	0.001 U	0.001 U	0.001 U	**0.0011 J**
Cadmium, Total	0.005	0.001 U	0.001 U	0.001 U	**0.0023**	**0.0016 J**	0.001 U	0.001 U	0.001 U	0.005 U
Chromium, Total	0.1	**0.0017 J**	0.0032 U	0.002 U	**0.052**	**0.054**	0.002 U	**0.0025**	0.0034 U	**0.026**
Cobalt, Total	0.006	**0.0007**	**0.025**	**0.0049**	**0.026**	**0.026**	**0.0054**	**0.0048**	**0.0031**	**0.012**
Fluoride	4	**0.49**	**0.32**	**0.3**	**0.4 J+**	**0.51**	**0.53 J+**	**0.39**	**0.37 J+**	**0.083 J**
Lead, Total	0.015	**0.00084 J**	0.001 U	**0.00023 J**	**0.038**	**0.026**	**0.00033 J**	**0.00083 J**	**0.0043**	**0.02**
Lithium, Total	0.04	**0.057**	**0.004 J**	**0.014**	**0.031**	**0.069**	0.005 U	**0.0078**	**0.0041 J**	**0.047**
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	**0.00038**	**0.00019 J**	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.03**	**0.0011 J**	**0.0007 J**	**0.0078**	**0.0078 J**	**0.0099**	**0.0089**	**0.0011 J**	**0.0037 J**
Selenium, Total	0.05	**0.0053**	0.005 U	**0.0066**	**0.0065**	**0.026**	0.005 U	**0.0068**	0.005 U	**0.031**
Thallium, Total	0.002	0.001 U	0.001 U	0.001 U	**0.0009 J**	**0.00096 J**	0.001 U	0.001 U	0.001 U	0.005 U
Radiological (pCi/L)										
Radium-226	NA	**0.543 ± 0.147**	**0.56 ± 0.29**	0.0634 U ± 0.0737	**2.57 ± 0.584**	**0.560 ± 0.22**	**0.404 ± 0.159**	0.116 U ± 0.104	**0.846 ± 0.224**	**0.606 ± 0.226**
Radium-228	NA	**0.535 ± 0.307**	0.60 U ± 0.39	0.246 U ± 0.302	2.81 U ± 1.93	0.217 U ± 0.45	**1.83 ± 1.11**	0.477 U ± 0.354	**1.54 ± 0.735**	**1.18 ± 0.569**
Radium-226 & 228	5	**1.08 ± 0.34**	**1.16 J ± 0.486**	0.310 U ± 0.311	**5.38 J ± 2.02**	**0.778 ± 0.501**	**2.24 ± 1.12**	**0.593 ± 0.369**	**2.38 ± 0.768**	**1.78 ± 0.612**
Field Parameters										
Temperature (Deg C)	NA	**18.85**	**17.71**	**19.53**	**29.7**	**20.11**	**33.68**	**19.35**	**25.99**	**19.24**
Dissolved Oxygen, Field (mg/L)	NA	**3.73**	**0.03**	**0.25**	**8.31**	**4.89**	**2.14**	**1.09**	**1.55**	**1.14**
Conductivity, Field (mS/cm)	NA	**1.592**	**1.144**	**1.1326**	-	**1.1641**	**1.6096**	**1.6303**	**1.5681**	**1.7555**
ORP, Field (mv)	NA	**-96.5**	**-152.2**	**-104.1**	**122.8**	**43.7**	**-142.5**	**-7.4**	**-97.7**	**-63.9**
Turbidity, Field (NTU)	NA	**35.54**	**45.14**	**21.5**	**0.72**	**1088**	**183.72**	**0.27**	**63.06**	**486.26**
pH, Field (SU)	NA	**7.2**	**6.9**	**6.63**	**7.79**	**7.33**	**7.13**	**8.14**	**6.8**	**6.51**

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TABLE II
SUMMARY OF GROUNDWATER QUALITY DATA
EAST ASH POND - MAY THROUGH OCTOBER 2019
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Action Level	Downgradient							
Location Name		CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5	CCR-AP-5I	CCR-AP-5I	CCR-AP-6	CCR-AP-6
Sample Name	Maximum	CCR-AP-5-20190528	BLIND DUPLICATE-20190528	CCR-AP-5-20191023	BLIND DUPLICATE-20191023	CCR-AP-5I-20190612	CCR-AP-5I-20191023	CCR-AP-6-20190528	CCR-AP-6-20191022
Sample Date	Contaminant	05/28/2019	05/28/2019	10/23/2019	10/23/2019	06/12/2019	10/23/2019	05/28/2019	10/22/2019
	Level					180-91361-1			
Lab Sample ID		180-90609-5	180-90609-10	180-97809-5	180-97809-14	1906573-1	180-97809-6	180-90609-6	180-97809-7
Detection Monitoring - EPA Appendix III Constituents (mg/L)									
Boron, Total	NA	**35 J-**	**34 J-**	**16**	**8.8**	**14**	**2.5**	**0.85 J-**	**0.28**
Calcium, Total	NA	**260**	**270**	**220**	**220**	**250**	**120**	**190**	**200**
Chloride	NA	**160**	**170**	**59**	**61**	**240**	**80**	**39**	**37**
Fluoride	4	**1.2 J+**	**1.3 J+**	**1.3**	**1.3**	**0.31**	**0.25**	**0.67 J+**	**0.46**
Sulfate	NA	**860**	**930**	**670**	**680**	**700**	**390**	**7.5**	**3.9**
Total Dissolved Solids (TDS)	NA	**2100**	**2000**	**1500**	**1500**	**1700**	**980**	**1000**	**1000**
pH (lab) (SU)	NA	**7.3 J**	**7.3 J**	**7.5 HF**	**7.5 HF**	**7 J**	**7.4 HF**	**7.4 J**	**7.4 HF**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)									
Antimony, Total	0.006	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	**0.00039 J**	**0.00083 J**	0.002 U
Arsenic, Total	0.01	**0.0011**	**0.0013**	**0.00066 J**	**0.00079 J**	**0.00072 J**	**0.00062 J**	**0.11**	**0.092**
Barium, Total	2	**0.04**	**0.042**	**0.042**	**0.043**	**0.085**	**0.035**	**0.69**	**0.6**
Beryllium, Total	0.004	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.00069 J**	0.001 U
Cadmium, Total	0.005	**0.00051 J**	**0.00053 J**	**0.00016 J**	0.001 U	0.001 U	0.001 U	**0.0006 J**	**0.00018 J**
Chromium, Total	0.1	0.0027 U	0.0028 U	0.002 U	0.002 U	0.002 U	0.002 U	**0.028**	**0.0075**
Cobalt, Total	0.006	**0.0031**	**0.0031**	**0.0023**	**0.0022**	**0.00048 J**	**0.00047 J**	**0.018**	**0.006**
Fluoride	4	**1.2 J+**	**1.3 J+**	**1.3**	**1.3**	**0.31**	**0.25**	**0.67 J+**	**0.46**
Lead, Total	0.015	**0.0011**	**0.0017**	**0.00013 J**	0.001 U	**0.00023 J**	0.001 U	**0.024**	**0.0049**
Lithium, Total	0.04	**0.087**	**0.086**	**0.095**	**0.091**	**0.035**	**0.035**	**0.014**	**0.0098**
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.38**	**0.38**	**0.53**	**0.52**	**0.0017 J**	**0.0072**	**0.028**	**0.023**
Selenium, Total	0.05	0.005 U	0.005 U	**0.007**	**0.0075**	0.005 U	**0.009**	0.005 U	**0.0053**
Thallium, Total	0.002	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	**0.00018 J**	0.001 U
Radiological (pCi/L)									
Radium-226	NA	**0.107 ± 0.0722**	**0.146 ± 0.0812**	**0.103 ± 0.0685**	0.0299 U ± 0.0704	**0.85 ± 0.36**	0.0924 U ± 0.0773	**6.34 J- ± 1.43**	**0.567 ± 0.163**
Radium-228	NA	0.257 U ± 0.341	0.435 U ± 0.42	**0.497 ± 0.256**	**0.588 ± 0.301**	0.40 U ± 0.36	-0.0597 U ± 0.26	3.90 UJ ± 4.41	**0.675 ± 0.337**
Radium-226 & 228	5	0.364 UJ ± 0.349	0.581 UJ ± 0.428	**0.599 ± 0.265**	**0.617 ± 0.309**	**1.25 J ± 0.509**	0.0327 U ± 0.271	**10.2 J- ± 4.64**	**1.24 ± 0.374**
Field Parameters									
Temperature (Deg C)	NA	**20.61**	**20.61**	**18.55**	**18.55**	**17.93**	**20.04**	**35.64**	**19.94**
Dissolved Oxygen, Field (mg/L)	NA	**0.04**	**0.04**	**0.21**	**0.21**	**0.03**	**0.21**	**2.55**	**2.41**
Conductivity, Field (mS/cm)	NA	**2.1567**	**2.1567**	**1.1217**	**1.1217**	**2.4352**	**1.4368**	**1.4215**	**1.7371**
ORP, Field (mv)	NA	**35.3**	**35.3**	**76.8**	**76.8**	**205**	**-168.5**	**-229.3**	**-110.3**
Turbidity, Field (NTU)	NA	**87.1**	**87.1**	**1.44**	**1.44**	**72.85**	**2.39**	**390.25**	**92.38**
pH, Field (SU)	NA	**7.25**	**7.25**	**6.94**	**6.94**	**7.06**	**7.18**	**7.28**	**7.16**

ABBREVIATIONS AND NOTES:

CCR: Coal Combustion Residuals.
mg/L: milligram per liter.
pCi/L: picoCurie per liter.
SU: standard units.
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Results in **bold** are detected.

- USEPA. 2016. Final Rule: Disposal of Coal Combustion Residuals from Electric Utilities. July 26. 40 CFR Part 257. https://www.epa.gov/coalash/coal-ash-rule

TABLE II
SUMMARY OF GROUNDWATER QUALITY DATA
EAST ASH POND - MAY THROUGH OCTOBER 2019
F.B. CULLEY GENERATING STATION
NEWBURGH, INDIANA

Location Group	Action Level	Downgradient					
Location Name		CCR-AP-6I	CCR-AP-6I	CCR-AP-8	CCR-AP-8	CCR-AP-8I	CCR-AP-8I
Sample Name	Maximum	CCR-AP-6I-20190612	CCR-AP-6I-20191024	CCR-AP-8-20190528	CCR-AP-8-20191022	CCR-AP-8I-20190612	CCR-AP-8I-20191024
Sample Date	Contaminant	06/12/2019	10/24/2019	05/28/2019	10/22/2019	06/12/2019	10/24/2019
	Level	180-91361-2				180-91361-3	
Lab Sample ID		1906573-3	180-97809-8	180-90609-8	180-97809-9	1906573-4	180-97809-10
Detection Monitoring - EPA Appendix III Constituents (mg/L)							
Boron, Total	NA	**12**	**12**	**0.12 J**	0.08 U	**18**	**8**
Calcium, Total	NA	**340**	**560**	**270**	**310**	**490**	**380**
Chloride	NA	**350**	**170**	**15**	**15**	**130**	**350**
Fluoride	4	**0.19 J+**	**0.13 J**	**0.51 J+**	**0.072 J**	**0.12 J+**	**0.24 J**
Sulfate	NA	**860**	**1400**	**0.99 J**	**2**	**1100**	**1000**
Total Dissolved Solids (TDS)	NA	**2300**	**2600**	**1200**	**1300**	**2200**	**2400**
pH (lab) (SU)	NA	**6.9 J**	**7.3 HF**	**6.9 J**	**7.1 HF**	**7.4 J**	**6.9 HF**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)							
Antimony, Total	0.006	0.002 U	0.002 U	**0.00046 J**	**0.00043 J**	0.002 U	0.002 U
Arsenic, Total	0.01	**0.0028**	**0.0049**	**0.1**	**0.09**	**0.0051**	**0.0022**
Barium, Total	2	**0.28**	**0.067**	**0.49**	**0.65**	**0.063**	**0.27**
Beryllium, Total	0.004	**0.00019 J**	0.001 U	0.001 U	0.001 U	**0.00018 J**	0.001 U
Cadmium, Total	0.005	0.001 U	**0.00022 J**	0.001 U	**0.00019 J**	**0.00022 J**	**0.00018 J**
Chromium, Total	0.1	0.0026 U	0.002 U	0.0034 U	**0.0067**	0.0033 U	0.002 U
Cobalt, Total	0.006	**0.00062 J+**	**0.0025**	**0.0044**	**0.0054**	**0.0031**	**0.00037 J**
Fluoride	4	**0.19 J+**	**0.13 J**	**0.51 J+**	**0.072 J**	**0.12 J+**	**0.24 J**
Lead, Total	0.015	0.001 U	**0.0011**	**0.0012**	**0.003**	0.001 U	**0.00046 J**
Lithium, Total	0.04	**0.33**	**0.056**	**0.0031 J**	**0.0093**	**0.047**	**0.41**
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.34**	**0.83**	**0.0099**	**0.012**	**0.86**	**0.31**
Selenium, Total	0.05	0.005 U	**0.0041 J**	0.005 U	**0.007**	0.005 U	**0.0062**
Thallium, Total	0.002	0.001 U	0.001 U	0.001 U	0.001 U	**0.00013 J**	0.001 U
Radiological (pCi/L)							
Radium-226	NA	**1.31 ± 0.47**	0.0977 U ± 0.0836	**0.443 ± 0.148**	**0.295 ± 0.143**	**0.46 ± 0.24**	**1.14 ± 0.204**
Radium-228	NA	**1.76 ± 0.58**	0.282 U ± 0.258	0.0635 UJ ± 0.848	0.431 U ± 0.358	**0.88 ± 0.42**	**1.28 ± 0.323**
Radium-226 & 228	5	**3.07 ± 0.747**	0.380 U ± 0.271	0.506 UJ ± 0.861	**0.726 ± 0.386**	**1.34 ± 0.484**	**2.42 ± 0.382**
Field Parameters							
Temperature (Deg C)	NA	**20.34**	**19.12**	**29.13**	**22.28**	**18.71**	**18.19**
Dissolved Oxygen, Field (mg/L)	NA	**0.03**	**0.16**	**2.9**	**1.41**	**0.04**	**0.07**
Conductivity, Field (mS/cm)	NA	**2.6443**	**2.7861**	**1.409**	**2.2261**	**3.0502**	**3.1838**
ORP, Field (mv)	NA	**-182**	**-26.4**	**-98**	**-106.6**	**-231.7**	**-107.2**
Turbidity, Field (NTU)	NA	**35.69**	**43.2**	**40.92**	**112.99**	**25.06**	**12.85**
pH, Field (SU)	NA	**7.36**	**7.06**	**7.04**	**7.06**	**7.14**	**6.77**

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HALEY ALDRICH

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24 September 2020
File No. 129420

TO: Southern Indiana Gas and Electric Company

FROM: Haley & Aldrich, Inc.
[Steven F. Putrich, P.E., Project Principal
Mark Miesfeldt, Lead Hydrogeologist]

SUBJECT: May 2020 Sampling Results and Assessment Monitoring Statistical Analysis Summary Pursuant to 40 CFR § 257.96(b)
F.B. Culley Generating Station – East Ash Pond – Newburgh, Indiana

Southern Indiana Gas and Electric Company (SIGECO) is implementing the 17 April 2015 United States Environmental Protection Agency Federal Coal Combustion Residuals (CCR) Rule (40 CFR § 257 and 261) for the F.B. Culley Generating Station, in Warrick County near the communities of Yankeetown and Newburgh, Indiana. Detection monitoring events occurred in 2016 and 2017. The results of the sampling events were compared to background using appropriate statistical methods to determine if Appendix III constituents were present at concentrations above background. The result of the statistical analysis identified statistically significant increases of Appendix III constituents downgradient of the East Ash Pond (EAP) thereby triggering Assessment Monitoring and respective notification of the same.

During the Assessment Monitoring phase, groundwater samples were collected from the CCR monitoring well network. Samples were collected in June, and August 2018 and subsequently analyzed for the Appendix III and Appendix IV constituents as required by 40 CFR § 257.95(b) and 40 CFR § 257.95(d)(1). Concurrent with the second assessment sampling round, and as required by 40 CFR § 257.95(h), groundwater protection standards (GWPS) were established for the detected Appendix IV constituents. The assessment monitoring sampling results were compared to the GWPS to determine if statistically significant levels (SSL) of Appendix IV constituents were present downgradient of the EAP. The results of this evaluation indicated that arsenic and molybdenum were present in groundwater at SSLs above the GWPS thereby requiring notification as established by 40 CFR § 105(h)(8) and triggering an assessment of corrective measures.

As a result of this determination, and in accordance with 40 CFR § 257.95(g)(3), a field investigation was initiated to determine whether a source other than the EAP caused the arsenic and molybdenum contamination. Soil and groundwater sampling results confirmed that arsenic was naturally occurring in the fine grained, organic rich, alluvial soil and documented the geochemical conditions required to mobilize arsenic through the process of reductive dissolution. The sampling and analysis for the molybdenum alternate source evaluation was conducted to evaluate the potential for the naturally occurring coal seam, identified in the boring for CCR-AP-5, to be an alternate source for molybdenum. The molybdenum evaluation concluded that the naturally occurring coal was a contributing source of molybdenum but the CCR material in the EAP was the primary source.

As required by 40 CFR § 257.95(b) and 40 CFR § 257.95(d)(1), semiannual groundwater sampling and analysis continued for the EAP in 2020. The first round of semiannual groundwater sampling was conducted in May 2020. Analytical results for the May 2020 semiannual sampling event are summarized in Table 1. For the EAP a statistical analysis of the May 2020 analytical results was finalized within 90-days of completion of sampling and analysis as required by 40 CFR § 257.93(g). Downgradient wells were compared to each constituents' respective GWPS. The assessment monitoring statistical analysis summary is provided in Table 2.

If the detected constituent was greater than the associated GWPS for that Unit, pursuant to 40 CFR § 257.93 (f)(5), the confidence interval method was used to evaluate if that Appendix IV constituent was present at an SSL. Intrawell statistical analysis was used for arsenic as a result of the alternate source demonstration. Based on the comparisons outlined above, the results of the statistical analyses conducted for those detected Appendix IV constituents confirm that molybdenum remains as the only constituent present at SSLs above GWPSs downgradient of the EAP. This information is being provided for SIGECO's records. Since no new constituents were identified at SSLs above the GWPS, further notifications associated with the statistical analysis of the May 2020 sampling results are not required at this time.

Attachments:
Table 1 - Summary of Analytical Results – May 2020
Table 2 - Assessment Monitoring Statistical Analysis Summary – May 2020

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TABLE I
SUMMARY OF ANALYTICAL RESULTS - MAY 2020
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, IN

Location Group	Action Level	Background		
Location Name	Maximum Contaminant Level	CCR-AP-1R	CCR-AP-7	CCR-AP-9
Sample Name		CCR-AP-1-20200519	CCR-AP-7-20200518	CCR-AP-9-20200519
Sample Date		05/19/2020	05/18/2020	05/19/2020
Lab Sample ID		180-106111-1	180-106111-9	180-106111-12
Detection Monitoring - EPA Appendix III Constituents (mg/L)				
Boron, Total	NA	**0.74**	**0.12**	**0.55 J+**
Calcium, Total	NA	**64**	**130**	**120**
Chloride	NA	**17**	**28**	**9.7**
Fluoride	4	**0.52**	**0.29**	**0.37**
pH (lab) (SU)	NA	**7.8 J**	**7.5 J**	**7.5 J**
Sulfate	NA	**180**	**76**	**120**
Total Dissolved Solids (TDS)	NA	**980**	**650**	**650**
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)				
Antimony, Total	0.006	**0.002 J**	**0.00083 J**	**0.00069 J**
Arsenic, Total	0.01	**0.025**	**0.015**	**0.0055**
Barium, Total	2	**0.3**	**0.19**	**0.19**
Beryllium, Total	0.004	**0.0043 J**	**0.00027 J**	**0.00058 J**
Cadmium, Total	0.005	0.005 U	0.001 U	0.001 U
Chromium, Total	0.1	**0.084**	**0.0062**	**0.011**
Cobalt, Total	0.006	**0.048**	**0.0049**	**0.008**
Fluoride	4	**0.52**	**0.29**	**0.37**
Lead, Total	0.015	**0.05**	**0.006**	**0.0066 J+**
Lithium, Total	0.04	**0.13**	**0.018**	**0.037**
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	**0.0096 J**	**0.002 J**	**0.0028 J**
Selenium, Total	0.05	**0.025**	**0.0028 J**	**0.0037 J**
Thallium, Total	0.002	0.005 U	0.001 U	0.001 U
Radiological (pCi/L)				
Radium-226	NA	**1.47 ± 0.35**	0.0602 U ± 0.147	**1.22 ± 0.411**
Radium-228	NA	1.34 U ± 0.599	0.242 U ± 0.611	0.795 U ± 0.684
Radium-226 & 228	5	**2.81 J+ ± 0.694**	0.302 U ± 0.628	**2.01 J ± 0.798**
Field Parameters				
Temperature (Deg C)	NA	**16.41**	**16.96**	**18.23**
Dissolved Oxygen, Field (mg/L)	NA	**1.37**	**0.05**	**4.09**
Conductivity, Field (mS/cm)	NA	**1.3261**	**1.004**	**1.0932**
ORP, Field (mv)	NA	**-33.7**	**-129.6**	**-8.2**
Turbidity, Field (NTU)	NA	**1938**	**23.16**	**815.5**
pH, Field (SU)	NA	**7.61**	**7.29**	**7.76**

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TABLE I
SUMMARY OF ANALYTICAL RESULTS - MAY 2020
SOUTHERN INDIANA GAS AND ELECTRIC COMPANY
F.B. CULLEY GENERATING STATION
NEWBURGH, IN

Location Group	Action Level	Downgradient										
Location Name	Maximum Contaminant Level	CCR-AP-2	CCR-AP-3	CCR-AP-4	CCR-AP-5	CCR-AP-5	CCR-AP-5I	CCR-AP-6	CCR-AP-6I	CCR-AP-8	CCR-AP-8I	CCR-AP-11
Sample Name		CCR-AP-2-20200520	CCR-AP-3-20200520	CCR-AP-4-20200520	CCR-AP-5-20200519	BLIND DUPLICATE-20200519	CCR-AP-5I-20200519	CCR-AP-6-20200520	CCR-AP-6I-20200519	CCR-AP-8-20200520	CCR-AP-8I-20200519	CCR-AP-11-20200520
Sample Date		05/20/2020	05/20/2020	05/20/2020	05/19/2020	05/19/2020	05/19/2020	05/20/2020	05/19/2020	05/20/2020	05/19/2020	05/20/2020
Lab Sample ID		180-106111-2	180-106111-3	180-106111-4	180-106111-5	180-106111-14	180-106111-6	180-106111-7	180-106111-8	180-106111-10	180-106111-11	180-106111-13
Detection Monitoring - EPA Appendix III Constituents (mg/L)												
Boron, Total	NA	12	0.24	0.1	14	13	13	0.67	19	0.1 U	12	0.21 J+
Calcium, Total	NA	260	180	130	170	170	230	200	510	260	380	110
Chloride	NA	230	24	16	73	76	250	40	160	16	390	23
Fluoride	4	0.35	0.36	0.64	1.4	1.5	0.35	0.44	0.086 J	0.3	0.25 U	0.34
pH (lab) (SU)	NA	6.9 J	7.4 J	6.8 J	7.5 J	7.5 J	7.1 J	7.5 J	7.4 J	7.3 J	7 J	6.7 J
Sulfate	NA	400	2.2 J+	6	440	430	670	7.9	1500	2.4 J+	960	430
Total Dissolved Solids (TDS)	NA	1400	950	660	1100	1100	1900	950	2300	1100	2200	840
Assessment Monitoring - EPA Appendix IV Constituents (mg/L)												
Antimony, Total	0.006	0.0021 J	0.002 U	0.002 U	0.002 U	0.002 U	0.002 U	0.00049 J	0.002 U	0.0004 J	0.002 U	0.002 U
Arsenic, Total	0.01	0.019	0.083	0.15	0.00073 J	0.00071 J	0.00097 J	0.11	0.0038	0.11	0.0023	0.048
Barium, Total	2	0.24	0.42	0.57	0.059	0.058	0.09	0.63	0.036	0.53	0.24	0.29
Beryllium, Total	0.004	0.002 J	0.001 U	0.001 U	0.001 U	0.001 U	0.0002 J	0.00019 J	0.001 U	0.00025 J	0.001 U	0.001 U
Cadmium, Total	0.005	0.005 U	0.001 U	0.001 U	0.001 U	0.00027 J	0.001 U	0.001 U	0.001 U	0.00028 J	0.001 U	0.001 U
Chromium, Total	0.1	0.051	0.0029	0.002 U	0.002 U	0.002 U	0.0038	0.0075	0.002 U	0.0029	0.002 U	0.002 U
Cobalt, Total	0.006	0.031	0.0051	0.0014	0.00036 J	0.00034 J	0.0022	0.0052	0.0018	0.0064	0.00014 J	0.03
Fluoride	4	0.35	0.36	0.64	1.4	1.5	0.35	0.44	0.086 J	0.3	0.25 U	0.34
Lead, Total	0.015	0.043	0.0014 J+	0.0015 J+	0.001 U	0.001 U	0.0026 J+	0.0046	0.0018 J+	0.0017 J+	0.001 U	0.001 U
Lithium, Total	0.04	0.036	0.005 U	0.0046 J	0.05	0.049	0.043	0.0042 J	0.05	0.005 U	0.37	0.005 U
Mercury, Total	0.002	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum, Total	0.1	0.0057 J	0.01	0.005 U	0.21	0.21	0.0017 J	0.024	0.77	0.013	0.28	0.00063 J
Selenium, Total	0.05	0.016 J	0.0019 J	0.0018 J	0.0018 J	0.002 J	0.0028 J	0.0021 J	0.005 U	0.0032 J	0.005 U	0.005 U
Thallium, Total	0.002	0.005 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Radiological (pCi/L)												
Radium-226	NA	0.355 ± 0.211	0.770 ± 0.257	1.03 ± 0.328	0.113 U ± 0.137	0.194 ± 0.139	0.944 ± 0.369	0.345 ± 0.189	0.212 U ± 0.209	0.572 ± 0.231	0.887 ± 0.272	0.255 ± 0.151
Radium-228	NA	0.581 U ± 0.555	0.252 U ± 0.408	0.395 U ± 0.63	0.254 U ± 0.54	0.0410 U ± 0.409	0.256 U ± 0.689	0.988 ± 0.571	0.565 U ± 0.809	0.519 U ± 0.449	1.76 ± 0.583	0.412 U ± 0.342
Radium-226 & 228	5	0.936 J ± 0.594	1.02 J ± 0.482	1.43 J ± 0.71	0.367 U ± 0.557	0.235 UJ ± 0.432	1.20 J ± 0.782	1.33 ± 0.601	0.776 U ± 0.836	1.09 J ± 0.505	2.64 ± 0.643	0.666 J ± 0.374
Field Parameters												
Temperature (Deg C)	NA	18.22	16.83	16.4	16.63	16.63	16.95	17.38	18.13	17.64	17.11	15.86
Dissolved Oxygen, Field (mg/L)	NA	4.79	3.85	2.83	0.16	0.16	0.28	3.26	0.21	2.29	0.27	0.27
Conductivity, Field (mS/cm)	NA	1.9069	1.1803	1.3146	1.292	1.292	2.48	1.6714	2.8202	2.0354	3.1519	1.2642
ORP, Field (mv)	NA	-12.4	-132.1	-69.8	43.4	43.4	-57.9	-94.7	-37.2	-104.4	-118.5	-110.3
Turbidity, Field (NTU)	NA	801.01	0.04	220.36	0.47	0.47	119.76	61.95	0.58	48.03	0.73	12.56
pH, Field (SU)	NA	6.71	7.28	6.76	7.25	7.25	6.99	7.51	7.25	6.97	6.95	6.8

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Table II
F.B. Culley EAP Generating Station
Assessment Monitoring Statistical Analysis Summary - May 2020
Prepared: September 18, 2020

									MCL Comparison								Inter-well Analysis				Intra-well Analysis			GWPS		
Location Id	Frequency of Detection	Percent Non-Detects	Maximum Detect	Variance	Standard Deviation	Coefficient of Variance	CCR MCL/RSL	Report Result Unit	Detection Exceedances (Y/N)	Number of Detection Exceedances	Number of Non-Detection Exceedances	Outlier Presence	Outlier Removed	Trend	Distribution Group	Distribution Well*	May 2020 Concentration (mg/L)	Detect?	Upper Tolerance Limit (mg/L)	SSI (Exceedance above Background at Individual Well)	Upper Prediction Limits (mg/L)		SSI (Exceedance above Background at Individual Well)	Groundwater Protection Standard (Higher of MCL/RSL or Upper Tolerance Limit) mg/L	Exceedance above GWPS at Individual Well	SSL
CCR Appendix-IV: Antimony, Total (mg/L)																										
CCR-AP-1R	8/14	43%	0.0025	0.00004777	0.006912	1.476	0.006	mg/L	N	0	3	N	N	Stable		Non-parametric										
CCR-AP-7	3/16	81%	0.00083	3.636E-07	0.000603	0.3494	0.006	mg/L	N	0	0	Y	N	Stable	Non-parametric	Non-parametric			0.02					0.020		
CCR-AP-9	10/14	29%	0.0079	0.00002967	0.005447	1.395	0.006	mg/L	Y	1	2	Y	N	Stable		Non-parametric										
CCR-AP-2	5/14	64%	0.0021	0.00002975	0.005454	1.291	0.006	mg/L	N	0	3	Y	N	Stable		Non-parametric	0.0021	Y		N					N	No
CCR-AP-3	2/14	86%	0.00058	3.217E-07	0.0005672	0.319	0.006	mg/L	N	0	0	Y	N	Stable		Non-parametric	0.002	N		N					N	No
CCR-AP-4	2/14	86%	0.00066	0.000005117	0.002262	0.958	0.006	mg/L	N	0	1	Y	N	Stable		Non-parametric	0.002	N		N					N	No
CCR-AP-5	1/14	93%	0.000058	0.0000238	0.004878	1.55	0.006	mg/L	N	0	1	Y	N	Stable		Non-parametric	0.002	N		N					N	No
CCR-AP-6	7/14	50%	0.0014	0.00000579	0.002406	1.227	0.006	mg/L	N	0	1	Y	N	Stable		Non-parametric	0.00049	Y		N					N	No
CCR-AP-8	9/14	36%	0.0018	4.424E-07	0.0006651	0.5153	0.006	mg/L	N	0	0	N	N	Stable		Normal	0.0004	Y		N					N	No
CCR Appendix-IV: Arsenic, Total (mg/L)																										
CCR-AP-1R	14/14	0%	0.038	0.0001625	0.01275	0.8539	0.01	mg/L	Y	6	0	N	N	Increase		Log-transformed										
CCR-AP-7	16/16	0%	0.018	0.00001846	0.004297	0.6127	0.01	mg/L	Y	2	0	N	N	Stable	Non-parametric	Log-transformed			0.038					0.038		
CCR-AP-9	14/14	0%	0.032	0.00004701	0.006856	0.7084	0.01	mg/L	Y	2	0	Y	N	Stable		Log-transformed										
CCR-AP-2	14/14	0%	0.032	0.0000912	0.00955	0.8837	0.01	mg/L	Y	6	0	N	N	Increase		Normal	0.029	Y		N	0.046	48	N		N	No
CCR-AP-3	14/14	0%	0.086	0.00005834	0.007638	0.1043	0.01	mg/L	Y	14	0	N	N	Stable		Normal	0.093	Y		Y	0.102	102.019	N		N	No
CCR-AP-4	14/14	0%	0.32	0.005247	0.07244	0.7596	0.01	mg/L	Y	14	0	Y	N	Increase		Normal	0.15	Y		Y	0.177	177.059	N		N	No
CCR-AP-5	12/14	14%	0.0015	0.000006175	0.002485	1.731	0.01	mg/L	N	0	0	Y	N	Stable		Non-parametric	0.00078	Y		N	0.030	30	N		N	No
CCR-AP-6	14/14	0%	0.12	0.0005841	0.02417	0.272	0.01	mg/L	Y	14	0	N	N	Increase		Normal	0.11	Y		Y	0.154	154.063	N		N	No
CCR-AP-8	14/14	0%	0.11	0.0004131	0.02032	0.2453	0.01	mg/L	Y	14	0	N	N	Increase		Normal	0.11	Y		Y	0.157	157.336	N		N	No
CCR Appendix-IV: Barium, Total (mg/L)																										
CCR-AP-1R	14/14	0%	0.59	0.03599	0.1897	0.8213	2	mg/L	N	0	0	N	N	Increase		Log-transformed										
CCR-AP-7	16/16	0%	0.19	0.0006917	0.0263	0.1895	2	mg/L	N	0	0	N	N	Stable	Non-parametric	Normal			0.720					2.000		
CCR-AP-9	14/14	0%	0.72	0.01902	0.1379	0.4876	2	mg/L	N	0	0	Y	N	Increase		Log-transformed										
CCR-AP-2	14/14	0%	0.52	0.02093	0.1447	0.6877	2	mg/L	N	0	0	N	N	Increase		Normal	0.24	Y		N					N	No
CCR-AP-3	14/14	0%	0.48	0.0008863	0.02977	0.06981	2	mg/L	N	0	0	N	N	Stable		Normal	0.43	Y		N					N	No
CCR-AP-4	14/14	0%	1.3	0.04017	0.2004	0.3001	2	mg/L	N	0	0	N	N	Stable		Normal	0.57	Y		N					N	No
CCR-AP-5	14/14	0%	0.068	0.0001155	0.01075	0.2644	2	mg/L	N	0	0	Y	N	Stable		Log-transformed	0.059	Y		N					N	No
CCR-AP-6	14/14	0%	0.69	0.003569	0.05974	0.09957	2	mg/L	N	0	0	N	N	Stable		Normal	0.63	Y		N					N	No
CCR-AP-8	14/14	0%	0.68	0.003031	0.05505	0.09331	2	mg/L	N	0	0	N	N	Stable		Normal	0.59	Y		N					N	No
CCR Appendix-IV: Beryllium, Total (mg/L)																										
CCR-AP-1R	14/14	0%	0.0066	0.000005096	0.002257	1.018	0.004	mg/L	Y	4	0	Y	N	Increase		Non-parametric										
CCR-AP-7	7/16	56%	0.00075	0.000000169	0.0004111	0.6121	0.004	mg/L	N	0	0	N	N	Stable	Non-parametric	Normal			0.007					0.007		
CCR-AP-9	14/14	0%	0.0041	9.189E-07	0.0009586	1.021	0.004	mg/L	Y	1	0	Y	N	Increase		Non-parametric										
CCR-AP-2	14/14	0%	0.0027	7.728E-07	0.0008791	0.7156	0.004	mg/L	N	0	0	N	N	Increase		Normal	0.002	Y		N					N	No
CCR-AP-3	0/14	100%		0	0	0	0.004	mg/L	N	0	0	NA	NA	NA	NA	NA	0.001	N		N					N	No
CCR-AP-4	11/14	21%	0.0011	1.361E-07	0.000369	0.6915	0.004	mg/L	N	0	0	N	N	Stable		Normal	0.001	N		N					N	No
CCR-AP-5	5/14	64%	0.00096	0.000006147	0.002479	1.704	0.004	mg/L	N	0	1	Y	N	Stable		Non-parametric	0.001	N		N					N	No
CCR-AP-6	11/14	21%	0.00069	0.000001548	0.001244	1.581	0.004	mg/L	N	0	1	Y	N	Stable		Non-parametric	0.00049	Y		N					N	No
CCR-AP-8	5/14	64%	0.00039	1.437E-07	0.0003791	0.5193	0.004	mg/L	N	0	0	N	N	Stable		Non-parametric	0.00025	Y		N					N	No
CCR Appendix-IV: Cadmium, Total (mg/L)																										
CCR-AP-1R	4/14	71%	0.00087	0.00001199	0.003462	1.287	0.005	mg/L	N	0	2	N	N	Stable		Non-parametric										
CCR-AP-7	2/16	88%	0.00032	7.025E-08	0.0002651	0.2933	0.005	mg/L	N	0	0	Y	N	Stable	Non-parametric	Non-parametric			0.010					0.010		
CCR-AP-9	9/14	36%	0.00022	0.000008745	0.002957	1.783	0.005	mg/L	N	0	1	Y	N	Stable		Non-parametric										
CCR-AP-2	11/14	21%	0.0023	0.000007882	0.002807	1.375	0.005	mg/L	N	0	1	Y	N	Increase		Non-parametric	0.001	N		N					N	No
CCR-AP-3	0/14	100%		0	0	0	0.005	mg/L	N	0	0	N	N	NA		NA	0.001	N		N					N	No
CCR-AP-4	6/14	57%	0.00048	0.00000151	0.001229	1.287	0.005	mg/L	N	0	0	N	N	Stable		Non-parametric	0.001	N		N					N	No
CCR-AP-5	11/14	21%	0.0012	0.000006526	0.002555	2.121	0.005	mg/L	N	0	1	Y	N	Stable		Non-parametric	0.001	N		N					N	No
CCR-AP-6	11/14	21%	0.0006	9.613E-08	0.00031	0.6337	0.005	mg/L	N	0	0	N	N	Stable		Normal	0.001	N		N					N	No
CCR-AP-8	3/14	79%	0.00028	1.138E-07	0.0003373	0.406	0.005	mg/L	N	0	0	N	N	Stable		Non-parametric	0.00028	Y		N					N	No
CCR Appendix-IV: Chromium, Total (mg/L)																										
CCR-AP-1R	14/14	0%	0.16	0.003076	0.05546	1.058	0.1	mg/L	Y	4	0	N	N	Increase		Log-transformed										
CCR-AP-7	11/16	31%	0.019	0.00001956	0.004422	1.171	0.1	mg/L	N	0	0	N	N	Stable	Non-parametric	Log-transformed			0.160					0.160		
CCR-AP-9	14/14	0%	0.15	0.001365	0.03695	1.515	0.1	mg/L	Y	1	0	N	N	Increase		Log-transformed										
CCR-AP-2	14/14	0%	0.082	0.0006437	0.02537	0.8346	0.1	mg/L	N	0	0	N	N	Increase		Normal	0.051	Y		N					N	No
CCR-AP-3	11/14	21%	0.0041	5.745E-07	0.000758	0.3121	0.1	mg/L	N	0	0	N	N	Stable		Normal	0.0023	Y		N					N	No
CCR-AP-4	12/14	14%	0.028	0.00007141	0.008451	0.9178	0.1	mg/L	N	0	0	N	N	Stable		Normal	0.002	N		N					N	No
CCR-AP-5	0/14	100%		0.00002319	0.004815	1.462	0.1	mg/L	N	0	0	Y	N	NA		NA	0.002	N		N					N	No
CCR-AP-6	14/14	0%	0.031	0.00008279	0.009099	0.6241	0.1	mg/L	N	0	0	N	N	Increase		Normal	0.0035	Y		N					N	No
CCR-AP-8	13/14	7%	0.012	0.000008983	0.002997	0.7336	0.1	mg/L	N	0	0	N	N	Stable		Normal	0.0039	Y		N					N	No

Table 2
F.B. Culley EAP Generating Station
Assessment Monitoring Statistical Analysis Summary - May 2020
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CCR Appendix-IV: Cobalt, Total (mg/L)																								
CCR-AP-1R	14/14	0%	0.081	0.0007091	0.02663	1.011	0.006	mg/L	Y	11	0	N	N	Increase		Log-transformed								
CCR-AP-7	16/16	0%	0.015	0.00001371	0.003702	1.267	0.006	mg/L	Y	1	0	N	N	Stable	Non-parametric	Log-transformed			0.081			0.081		
CCR-AP-9	14/14	0%	0.047	0.00009792	0.009895	0.6824	0.006	mg/L	Y	14	0	N	N	Stable		Log-transformed								
CCR-AP-2	14/14	0%	0.038	0.00008294	0.009107	0.4523	0.006	mg/L	Y	14	0	N	N	Increase		Normal	0.031	Y		N			N	No
CCR-AP-3	14/14	0%	0.0094	0.000001919	0.001385	0.2201	0.006	mg/L	Y	7	0	N	N	Decrease		Normal	0.0051	Y		N			N	No
CCR-AP-4	14/14	0%	0.013	0.00001164	0.003411	0.5514	0.006	mg/L	Y	7	0	N	N	Stable		Normal	[illegible]	Y		N			N	No
CCR-AP-5	14/14	0%	0.007	0.000004264	0.002065	0.4485	0.006	mg/L	Y	6	0	N	N	Decrease		Normal	[illegible]	Y		N			N	No
CCR-AP-6	14/14	0%	0.018	0.00001413	0.003759	0.3898	0.006	mg/L	Y	12	0	N	N	Increase		Normal	0.0052	Y		N			N	No
CCR-AP-8	14/14	0%	0.017	0.00001238	0.003519	0.3532	0.006	mg/L	Y	12	0	N	N	Decrease		Normal	[illegible]	Y		N			N	No
CCR Appendix-III: Fluoride (mg/L)																								
CCR-AP-1R	14/14	0%	3.24	0.04004	0.4004	0.7612	4	mg/L	N	0	0	Y	N	Stable		Non-parametric								
CCR-AP-7	16/16	0%	1.48	0.018424	0.27148	1.044	4	mg/L	N	0	0	N	N	Stable	Normal	Normal			0.612			4.000		
CCR-AP-9	14/14	0%	1.68	0.019268	0.27764	0.862	4	mg/L	N	0	0	Y	N	Stable		Non-parametric								
CCR-AP-2	14/14	0%	2.04	0.03548	0.37672	1.3184	4	mg/L	N	0	0	N	N	Stable		Non-parametric	[illegible]	Y		N			N	No
CCR-AP-3	13/14	7%	3.72	0.16032	0.8008	1.8348	4	mg/L	N	0	0	N	N	Stable		Normal	[illegible]	Y		N			N	No
CCR-AP-4	13/14	7%	2.56	0.05764	0.4804	1.3028	4	mg/L	N	0	0	N	N	Stable		Normal	[illegible]	Y		Y			N	No
CCR-AP-5	14/14	0%	5.6	0.22284	0.944	0.86	4	mg/L	N	0	0	N	N	Stable		Normal	[illegible]	Y		Y			N	No
CCR-AP-6	14/14	0%	2.68	0.05744	0.4792	0.9452	4	mg/L	N	0	0	N	N	Stable		Normal	[illegible]	Y		N			N	No
CCR-AP-8	13/14	7%	2.04	0.04776	0.4372	1.5372	4	mg/L	N	0	0	N	N	Stable		Normal	[illegible]	Y		N			N	No
CCR Appendix-IV: Lead, Total (mg/L)																								
CCR-AP-1R	14/14	0%	0.094	0.0009293	0.03048	1.022	0.015	mg/L	Y	6	0	N	N	Increase		Log-transformed								
CCR-AP-7	12/16	25%	0.02	0.0000259	0.005089	1.337	0.015	mg/L	Y	1	0	N	N	Stable	Non-parametric	Log-transformed			0.094			0.094		
CCR-AP-9	14/14	0%	0.041	0.00008857	0.009411	0.8567	0.015	mg/L	Y	2	0	N	N	Increase		Log-transformed								
CCR-AP-2	14/14	0%	0.051	0.0002827	0.01681	0.8407	0.015	mg/L	Y	7	0	N	N	Increase		Normal	[illegible]	Y		N			N	No
CCR-AP-3	11/14	21%	0.0014	1.082E-07	0.000329	0.4511	0.015	mg/L	N	0	0	N	N	Stable		Normal	[illegible]	Y		N			N	No
CCR-AP-4	14/14	0%	0.021	0.0000417	0.006457	0.9251	0.015	mg/L	Y	2	0	N	N	Stable		Normal	[illegible]	Y		N			N	No
CCR-AP-5	2/14	86%	0.0011	0.000005925	0.002434	1.535	0.015	mg/L	N	0	0	Y	N	Stable		Non-parametric	[illegible]	N		N			N	No
CCR-AP-6	14/14	0%	0.024	0.00004538	0.006736	0.6455	0.015	mg/L	Y	3	0	N	N	Increase		Normal	[illegible]	Y		N			N	No
CCR-AP-8	14/14	0%	0.0076	0.000003217	0.001794	0.8573	0.015	mg/L	N	0	0	N	N	Stable		Log-transformed	[illegible]	Y		N			N	No
CCR Appendix-IV: Lithium, Total (mg/L)																								
CCR-AP-1R	14/14	0%	0.23	0.004	0.06325	0.7153	0.04	mg/L	Y	11	0	N	N	Increase		Log-transformed								
CCR-AP-7	16/16	0%	0.039	0.00005505	0.00742	0.4826	0.04	mg/L	N	0	0	Y	N	Stable	Non-parametric	Non-parametric			0.230			0.230		
CCR-AP-9	14/14	0%	0.12	0.0005614	0.02369	0.5041	0.04	mg/L	Y	6	0	Y	N	Increase		Non-parametric								
CCR-AP-2	9/14	36%	0.069	0.003479	0.05899	1.103	0.04	mg/L	Y	2	5	Y	N	Stable		Log-transformed	[illegible]	Y		N			N	No
CCR-AP-3	0/14	100%		0.0004888	0.02211	0.6478	0.04	mg/L	N	0	9	Y	N	NA		NA	[illegible]	N		N			N	No
CCR-AP-4	9/14	36%	0.047	0.0004438	0.02107	0.7949	0.04	mg/L	Y	1	5	N	N	Stable		Normal	[illegible]	Y		N			N	No
CCR-AP-5	14/14	0%	0.15	0.0008407	0.02899	0.2513	0.04	mg/L	Y	14	0	N	N	Decrease		Normal	[illegible]	Y		N			N	No
CCR-AP-6	6/14	57%	0.016	0.003763	0.06134	1.284	0.04	mg/L	N	0	8	N	N	Stable		Non-parametric	[illegible]	Y		N			N	No
CCR-AP-8	4/14	71%	0.014	0.0004925	0.02219	0.7025	0.04	mg/L	N	0	8	N	N	Stable		Non-parametric	[illegible]	N		N			N	No
CCR Appendix-IV: Mercury, Total (mg/L)																								
CCR-AP-1R	0/13	100%		0	0	0	0.002	mg/L	N	0	0	NA	NA	NA		NA								
CCR-AP-7	0/13	100%		0	0	0	0.002	mg/L	N	0	0	NA	NA	NA	Non-parametric	NA			0.0002			0.002		
CCR-AP-9	0/13	100%		0	0	0	0.002	mg/L	N	0	0	NA	NA	NA		NA								
CCR-AP-2	2/13	85%	0.00038	2.523E-09	0.00005023	0.2357	0.002	mg/L	N	0	0	NA	NA	NA		NA	0.0002	N		N			N	No
CCR-AP-3	0/13	100%		0	0	0	0.002	mg/L	N	0	0	NA	NA	NA		NA	[illegible]	N		N			N	No
CCR-AP-4	0/13	100%		3.077E-09	0.00005547	0.2575	0.002	mg/L	N	0	0	NA	NA	NA		NA	0.0002	N		N			N	No
CCR-AP-5	0/13	100%		0	0	0	0.002	mg/L	N	0	0	NA	NA	NA		NA	0.0002	N		N			N	No
CCR-AP-6	0/13	100%		0	0	0	0.002	mg/L	N	0	0	NA	NA	NA		NA	[illegible]	N		N			N	No
CCR-AP-8	0/13	100%		0	0	0	0.002	mg/L	N	0	0	NA	NA	NA		NA	0.0002	N		N			N	No
CCR Appendix-IV: Molybdenum, Total (mg/L)																								
CCR-AP-1R	14/14	0%	0.015	0.000009176	0.003029	0.3255	0.1	mg/L	N	0	0	N	N	Stable		Normal								
CCR-AP-7	16/16	0%	0.013	0.00001086	0.003296	0.7264	0.1	mg/L	N	0	0	N	N	Decrease	Normal	Normal			0.013			0.100		
CCR-AP-9	14/14	0%	0.012	0.000008244	0.002871	0.4552	0.1	mg/L	N	0	0	N	N	Stable		Normal								
CCR-AP-2	14/14	0%	0.0078	0.000005989	0.002447	0.6889	0.1	mg/L	N	0	0	N	N	Increase		Normal	[illegible]	Y		N			N	No
CCR-AP-3	14/14	0%	0.014	0.00000319	0.001786	0.158	0.1	mg/L	N	0	0	N	N	Decrease		Normal	0.01	Y		N			N	No
CCR-AP-4	13/14	7%	0.0037	0.000001454	0.001206	0.5792	0.1	mg/L	N	0	0	N	N	Decrease		Normal	[illegible]	N		N			N	No
CCR-AP-5	14/14	0%	0.53	0.007508	0.08665	0.2476	0.1	mg/L	Y	14	0	N	N	Stable		Non-parametric	[illegible]	Y		Y			Y	Yes
CCR-AP-6	14/14	0%	0.033	0.00002229	0.004721	0.1826	0.1	mg/L	N	0	0	N	N	Increase		Normal	[illegible]	Y		Y			N	No
CCR-AP-8	14/14	0%	0.015	0.000001966	0.001402	0.1073	0.1	mg/L	N	0	0	N	N	Decrease		Normal	[illegible]	Y		Y			N	No
CCR Appendix-IV: Radium-226 & 228 (mg/L)																								
CCR-AP-1R	11/14	21%	6.73	4.596	2.144	0.5137	1	mg/L	Y	11	2	N	N	Stable		Normal								
CCR-AP-7	14/15	7%	1.72	1.25	1.118	0.9242	1	mg/L	Y	6	1	N	N	Stable	Log-transformed	Normal			6.730			6.730		
CCR-AP-9	13/14	7%	4.02	1.141	1.068	0.3818	1	mg/L	Y	13	1	N	N	Stable		Normal								
CCR-AP-2	13/14	7%	5.38	1.595	1.263	0.6439	1	mg/L	Y	9	0	N	N	Stable		Normal	[illegible]	Y		N			N	No
CCR-AP-3	13/14	7%	2.24	0.2384	0.4882	0.3401	1	mg/L	Y	11	1	N	N	Stable		Normal	[illegible]	Y		N			N	No
CCR-AP-4	14/14	0%	4.28	0.9471	0.9732	0.4023	1	mg/L	Y	14	0	N	N	Stable		Normal	[illegible]	Y		N			N	No
CCR-AP-5	11/14	21%	1.21	2.467	1.571	1.185	1	mg/L	Y	1	2	Y	N	Stable		Non-parametric	[illegible]	N		N			N	No
CCR-AP-6	13/14	7%	10.2	6.045	2.459	0.9032	1	mg/L	Y	13	1	Y	N	Increase		Non-parametric	[illegible]	Y		N			N	No
CCR-AP-8	13/14	7%	2.32	1.146	1.07	0.6271	1	mg/L	Y	11	1	N	N	Stable		Normal	[illegible]	Y		N			N	No

Table 2
F.B. Culley EAP Generating Station
Assessment Monitoring Statistical Analysis Summary - May 2020
Prepared: September 18, 2020

CCR Appendix-IV: Selenium, Total (mg/L)																								
CCR-AP-1R	5/14	64%	0.025	0.0003102	0.01761	1.209	0.05	mg/L	N	0	2	N	N	Increase		Non-parametric								
CCR-AP-7	3/14	79%	0.0028	0.000002759	0.001661	0.3949	0.05	mg/L	N	0	0	Y	N	Stable	Non-parametric	Non-parametric			0.050			0.050		
CCR-AP-9	5/14	64%	0.0099	0.00005825	0.007632	0.9995	0.05	mg/L	N	0	0	N	N	Stable		Non-parametric								
CCR-AP-2	8/14	43%	0.026	0.0001966	0.01402	1.283	0.05	mg/L	N	0	1	Y	N	Stable		Non-parametric	0.016	Y		N			N	No
CCR-AP-3	13/14	7%	0.0068	0.00000254	0.001594	0.6799	0.05	mg/L	N	0	0	N	N	Stable		Normal	0.0059	Y		N			N	No
CCR-AP-4	8/14	43%	0.031	0.00005906	0.007685	1.52	0.05	mg/L	N	0	0	N	N	Stable		Normal	0.0081	Y		N			N	No
CCR-AP-5	2/14	86%	0.007	0.0001463	0.0121	1.488	0.05	mg/L	N	0	1	N	N	NA		NA	0.0019	Y		N			N	No
CCR-AP-6	11/14	21%	0.0053	0.00003836	0.006194	1.511	0.05	mg/L	N	0	0	N	N	Increase		Non-parametric	0.0021	Y		N			N	No
CCR-AP-8	11/14	21%	0.007	0.00000319	0.001786	0.604	0.05	mg/L	N	0	0	N	N	Stable		Normal	0.0062	Y		N			N	No
CCR Appendix-IV: Thallium, Total (mg/L)																								
CCR-AP-1R	11/14	21%	0.0014	0.000001606	0.001267	1.334	0.002	mg/L	N	0	1	N	N	Stable		Normal								
CCR-AP-7	4/16	75%	0.00061	1.387E-07	0.0003724	0.4639	0.002	mg/L	N	0	0	N	N	Stable	Non-parametric	Non-parametric			0.005			0.005		
CCR-AP-9	9/14	36%	0.00098	0.000001605	0.001267	1.527	0.002	mg/L	N	0	1	N	N	Stable		Normal								
CCR-AP-2	12/14	14%	0.00099	0.000001578	0.001256	1.513	0.002	mg/L	N	0	1	N	N	Increase		Normal	0.005	N		N			N	No
CCR-AP-3	1/14	93%	0.0001	5.786E-08	0.0002405	0.2571	0.002	mg/L	N	0	0	N	N	Stable		Non-parametric	0.001	N		N			N	No
CCR-AP-4	8/14	43%	0.00026	0.000001664	0.00129	1.656	0.002	mg/L	N	0	1	N	N	Stable		Non-parametric	0.001	N		N			N	No
CCR-AP-5	3/14	79%	0.00018	0.000006179	0.002486	1.705	0.002	mg/L	N	0	1	Y	N	Stable		Non-parametric	0.001	N		N			N	No
CCR-AP-6	8/14	43%	0.00022	0.000001652	0.001285	1.631	0.002	mg/L	N	0	1	Y	N	Stable		Non-parametric	0.001	N		N			N	No
CCR-AP-8	5/14	64%	0.00029	1.901E-07	0.000436	0.6326	0.002	mg/L	N	0	0	N	N	Stable		Non-parametric	0.001	N		N			N	No

Appendix I
Description of Site Hydrogeology

2. Site Geology and Hydrogeology

2.1 SITE GEOLOGY

The Ohio River valley contains alluvial (river) and loess (windblown) deposits derived indirectly from continental ice sheets. The unconsolidated alluvial materials were transported down the Ohio River Valley in meltwater heavily loaded with entrained coarse-grained sediments deposited on top of the Pennsylvanian age shale, limestone and sandstone bedrock. Westerly winds simultaneously deposited fine-grained silty sediments. As a result, base levels of the valley floor increased in elevation and created natural levees and outwashes. These natural levees produced slackwater lakes which deposited thick sequences of silt and clay. When the ice sheets retreated, the sediment load in the Ohio River diminished and lowered base levels. Consequently, the river incised the slackwater lake sediments, sculpted lacustrine terraces, and deposited silty and clayey stream alluvium.

Soil borings drilled at the Site indicate that in the vicinity of the Ash Pond the uppermost geologic unit is comprised of alluvial deposits consisting of primarily silts and clays. In the upland areas to the north, the alluvial deposits are absent but instead consist of discontinuous layers of sand and consolidated shale.

The Site is located in the vicinity of the Wabash Valley and New Madrid seismic zones. The largest earthquake recorded (magnitude 5.2) proximal to the Site occurred in April 18, 2008 approximately 50 miles northwest of the facility.

2.2 SITE HYDROGEOLOGY

Hydrogeologic units are defined based on their ability to transmit groundwater or serve as confining units between zones of groundwater. In the vicinity of the Ash Pond, the uppermost aquifer occurs within unconsolidated Ohio River alluvial deposits consisting of silt and clay with discontinuous interbedded layers of sand. To the north of the Ash Pond the uppermost aquifer occurs in the shale and sandstone bedrock units. Recharge to the surficial aquifer occurs through direct surface infiltration.

Piezometric data recorded from the monitoring wells installed on-site shows that the configuration of the uppermost aquifer is primarily controlled by surface topography with some influence from the underlying weathered bedrock. Groundwater flow in the immediate vicinity of the Ash Pond is radial with an overall flow direction from the upland areas north of the Ash Pond to the south toward the Ohio River. Groundwater elevations vary seasonally but the groundwater flow patterns remain consistent.

Groundwater flow velocity in the uppermost aquifer beneath the Ash Pond was estimated using site-specific hydraulic conductivity, measured hydraulic gradients, and an assumed effective porosity of 25 percent. Hydraulic conductivity varied from 1.3E-3 cm/sec adjacent to the northern boundary of the Ash Pond to 5.5E-5 cm/sec in the upland area north of the Ash Pond. The hydraulic gradient north of the Ash Pond is 0.06 feet/foot. South of the Ash Pond the hydraulic gradient steepens to 0.1 feet/foot down to the Ohio River. Using the site-specific hydraulic conductivity and hydraulic gradients, and assuming an effective porosity of 25 percent the groundwater flow north of the Ash Pond is estimated to be 325 feet/year. To the south of the Ash Pond groundwater flow is estimated to be 25 feet/year.

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About AECOM

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